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EFFECTS OF COLD WEATHER UPON ARMORED COMBAT VEHICLES DURING THE FIRST WINTER CAMPAIGN, EASTERN FRONT, WORLD WAR II

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

BANTZ J. CRADDOCK, MAJ, AR
B.A., West Virginia University, 1971

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This study investigates the effect of cold weather upon the mechanized forces of the German Army and the Soviet Red Army during the first winter campaign on the eastern front of World War II, October 1941, through March, 1942. This thesis is concerned with the problems incurred by armored combat vehicles due to the winter elements (cold and snow), the solutions to those problems, and the impact upon operations.

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This study concludes that the elements of the Russian winter of 1941/42, adversely impacted ACV operations. The German forces were affected more than the Red Army in this respect. The cold weather had the greatest adverse impact upon mechanized warfare during this campaign. The most significant problem caused by cold weather for both forces was the freezing of ACV lubricants, fuel, and antifreeze. Deep snow cover was a significant problem also. Its impact was to virtually negate German ACV off-road mobility. Due to design differences, the Soviet ACV's had relatively excellent mobility in deep snow. Simply stated, the cold effects impacted upon getting the vehicle, or the system into opration; on the other hand, the snow effect was upon how well the ACV could perform its intended function after it was operational.

The weather-induced ACV problems caused a signficant impact upon German operations during this winter campaign, the most significant of which occurred in the operational arena. The winter conditions effectively precluded the Germans from being able to conduct operational maneuver, thus dictating a change in their strategy. The Germans were defeated during this campaign, however, the winter weather conditions were not the primary reason.

The effect of the winter weather upon Soviet tactical operations was minimal. At the operational and strategic levels, there appeared to be no impact.

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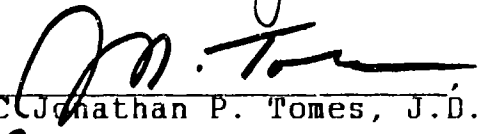
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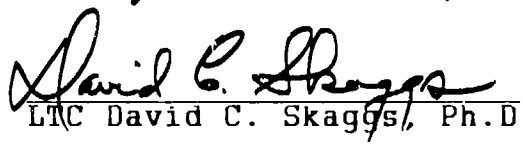
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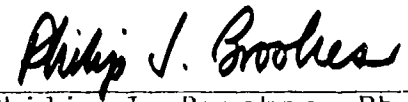
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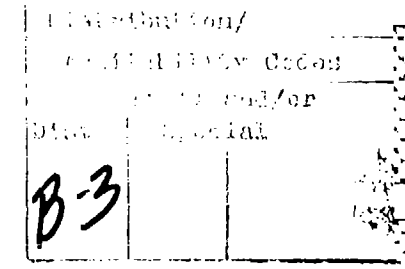

ABSTRACT

EFFECTS OF COLD WEATHER UPON ARMORED COMBAT VEHICLES DURING THE FIRST WINTER CAMPAIGN, EASTERN FRONT, WORLD WAR II, by Major Bantz J. Craddock, USA, 203 pages.

This study investigates the effect of cold weather upon the mechanized forces of the German Army and the Soviet Red Army during the first winter campaign on the eastern front of World War II, October 1941 through March 1942. This thesis is concerned with the problems incurred by armored combat vehicles due to the winter elements (cold and snow), the solutions to those problems and the impact upon operations.

This study concludes that the elements of the Russian winter of 1941/42 adversely impacted ACV operations. The German forces were affected more than the Red Army in this respect. The cold weather had the greatest adverse impact upon mechanized warfare during this campaign. The most significant problem caused by cold weather for both forces was the freezing of ACV lubricants, fuel, and antifreeze. Deep snow cover was a significant problem also. Its impact was to virtually negate German ACV off-road mobility. Due to design differences, the Soviet ACV's had relatively excellent mobility in deep snow. Simply stated, the cold effects impacted upon getting the vehicle, or the system, into operation; on the other hand, the snow effect was upon how well the ACV could perform its intended function after it was operational.

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The effect of the winter weather upon Soviet tactical operations was minimal. At the operational and strategic levels, there appeared to be no adverse impact.

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I received much help and assistance in the preparation of this thesis. I would like to gratefully acknowledge the sterling assistance of my thesis committee. LTC James M. Brogdon, Chairman, was invaluable throughout this entire effort, from the initial research through to the writing and editing phase. He provided timely guidance and helped me to keep on track. LTC Jonathan P. Tomes provided considerable assistance in keeping this thesis in perspective and in ensuring application for combat support and combat service support operations and personnel. I extend to LTC David A. Skaggs, Consulting Faculty member, my sincere appreciation for his help. LTC Skaggs' sage guidance enabled me to maintain my focus on the central thesis. Additionally, he directed me to pertinent research sources.

I would like to acknowledge the support of my family in this effort. I would like to thank my children, Zachary and Amanda, for their understanding of why dad was at the library and not at home like the other dads in the neighborhood. Most of all, I would like to thank my wife Linda, whose moral support, advice, and devotion enabled me to complete this project. If not one of the best years, it was, at least, one of the busiest..

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CHAPTER I

INTRODUCTION

Russia is a country easy to enter but hard to leave.

Jomini

The Russian-German campaign of World War II, commonly known and referred to as the eastern front, was a significant milestone in the annals of warfare. Much like Napoleon almost one hundred and thirty years before him, Hitler invaded Russia in the summer with grand designs. The power of the German armed forces was thought by Hitler to be sufficient to defeat the Soviets decisively before the onset of the ruthless Russian winter. However, the Germans found a different type of warfare. The days of the blitzkrieg, with German panzer divisions running rampant over the battlefields of Poland and France, were over. By December, 1941, six months after the invasion began, Russia became a vortex into which the bulk of the German military strength was drawn.[1] The Germans were faced with the situation they had hoped to avoid, namely, combat operations in a winter environment.

The purpose of this study was to determine what effects cold weather had upon German and Soviet armored combat vehicles (ACV's) during the first winter campaign of

1941/42. Were there problems experienced, and if so, what were they and what was the cause? Were solutions available or developed? What was the impact on both forces of the problems experienced? Did the impacts affect tactical or operational plans and actions? Were there strategic impacts or implications?

These questions were the basis for this study. They focused the research effort into three distinct areas: problem identification, problem solution, and problem impact. The impacts portion of this study considered the conduct of operations at the tactical, operational, and strategic levels of warfare. Where an assessment of impacts upon ACV's was not possible, implications were discussed. This was done to provide continuity across the three levels of operations and to permit the reader to draw his own conclusions, which may differ from those of the author.

The need for studies such as this one becomes readily apparent when the U. S. Army's force modernization program is considered. The current force modernization program is the Army's number one priority. Its objective is to improve the Army's war-fighting capability via the introduction of technically advanced, reliable and effective combat, combat support, and combat service support systems. The scope of the effort extends across hundreds of weapon and support systems within all theaters of operation. As these new

systems enhance capabilities, the demand for early fielding is considerable.

Therein lies the major concern. In our haste to develop and provide to our soldiers in the field improved combat effectiveness, have we accurately determined the operational capabilities of the new equipment at the extremes of the environmental limits under which it may have to operate? In order to reduce the design burden and accompanying costs, the extremes of the operating environmental limits, arctic and desert, are generally considered special requirements. As such, the system developers may address those requirements for operation through specialized hardware or procedural applications which, in effect, expand the normal operating range of the equipment.

Since this study deals with cold weather effects upon ACV's, let us look at this particular area. What happens when we subject ACV's to cold weather conditions beyond the limits for which they were designed? The problem is not so much for the arctic region, as deployment/employment of ACV's to those areas initiates a concurrent cold weather kit application. The problem arises when significant excursions occur outside the temperatures normally experienced in temperate zones. Given that scenario, it is critical to the conduct of military operations to know what to expect in the way of system problems. Do system problems develop? Are

there a solutions? What, if any, are the impacts upon mission accomplishment?

Carrying this logic path one step further involves the implication of cold-weather induced problems upon war-fighting doctrine. If doctrinal tenants are predicated upon specified system capabilities, then any degradation in system effectiveness jeopardizes the validity of the doctrine. The greater the degradation (due to the environmental excursion outside predicted limits) to the weapon system, the less supportable the doctrine becomes.

The Russo-German winter campaign of 1941/42 provided an excellent basis for this study. Large scale mechanized forces were used, particularly by the Germans. German ACV's were the most sophisticated systems in action at that time. They were designed for combat in a western European environment. The Red Army, though less mechanized, still had approximately twenty-four thousand tanks in its inventory at the beginning of the war (the Russians estimated the Germans had thirty-thousand).[2] Soviet soldiers were acclimated to the winter climate while the Germans were not. A most significant factor was that the winter of 1941/42 was unequaled throughout the war with respect to the harshness of its elements and its extended duration. This last factor supported a worst-case impact assessment on a relative basis.

The reader should be aware of several assumptions that were made when this study effort began The first assumption was that cold weather effects could adversely impact upon the operation and mission capability of ACV's. Although this seems almost redundant with respect to the scope of this study, it was essential to make this assumption at the beginning of the research effort. It was made in a positive fashion, i.e., problems were present, as opposed to a negative premise.

The next assumption made at the outset was that ACV's participated in the 1941/42 winter campaign on a large scale. That is, mechanized units were not put into a standdown status or pulled out of the line merely because of the onset of winter. The reader should not confuse large scale use with the organizational structure of mechanized forces. A simplified restatement of the assumption is that the same mechanized forces present for the late summer and fall campaign participated in the winter campaign, minus the normal battle and non-battle attritions.

Last, it was assumed that the source documents for this campaign were factually accurate with respect to the cause and effect of any particular problem during this campaign. This assumption applied to both combatants. This assumption will be further addressed in Chapter II.

There are several terms used throughout the study that merit definition at this point in order to enhance the

reader's comprehension. The first of these terms is armored combat vehicle, or ACV. For purposes of this study, an ACV was a track-laying combat vehicle capable of either direct or indirect fire. Functionally, there were four types of ACV's. There were tanks which were full-tracked, turreted vehicles. Next, there were self-propelled guns which were almost identical to tanks except they lacked turrets. There was self-propelled artillery used to deliver indirect field artillery fires in great volume. Last, there were armored personnel carriers (APC's). APC's were lightly armored, half-tracked vehicles used to carry infantry.[3] Appendix 1 provides system characteristics of the ACV's used during this campaign.

Extreme or bitter cold was defined as ambient temperatures less than minus twenty-five degrees Fahrenheit. Accordingly, cold was considered to include temperatures within the range of minus twenty-five degrees to plus thirty-two degrees Fahrenheit. This was an arbitrary selection on the part of the author although the delineating point (minus twenty-five degrees Fahrenheit) corresponds to the generally accepted low-end cold temperature design specification for present U. S. Army ACV's.

The winter campaign of 1941/42 on the eastern front, sometimes referred to in this study as the first winter campaign, covers the period from early October 1941 through March of 1942. The first winter campaign was waged entirely

during this period. That the duration of previous or subsequent winter seasons did not cover the same period as this winter was unimportant, except to reinforce the fact that this was an abnormally severe winter, the worst experienced on the eastern front during the entire conflict.

A distinction must be made between the tactical and operational levels of war. Tactical operations were generally conducted at or below division level and concerned the mechanics of combat, i.e., fire support for and the maneuver of elements to accomplish the unit's assigned mission. The winter's impact at the tactical level was primarily on how things were done.

The operational level involved divisional to army operations. At this level, the focus was on the positioning of such units in a manner to gain an advantage in order to bring about the defeat of an enemy force through tactical action. The winter's impact at the operational level was mainly on what things were done.

Fire control equipment is defined as those sighting and gun laying (deflection and elevation) components in ACV's used to lay the armament in the proper position to provide effective fire onto the designated target. Armament is defined as the weapons available on-board the ACV, either those permanently mounted or those capable of being dismounted, such as machineguns.

The organizational structure of the mechanized forces of both armies is described and discussed in Appendix 2. The reader will note that the structure of the Red Army forces was not as defined as that of the Germans. This was because the Red Army underwent a series of radical changes during the first two years of the war and the organizational structure was constantly changing.

Few acronyms and abbreviations have been used. The more important abbreviations used were: ACV - Armored Combat Vehicle; OKW - German Armed Forces High Command; OKH - German Army High Command; STAVKA - Soviet High Command; and ALB - Airland Battle.

The following chapter will provide a survey of the literature concerning this thesis and will discuss the methodology used in the conduct of the study. Chapter III will set the stage for the reader by providing a synopsis of the conflict up to and through the first winter campaign. Also covered in that chapter are the weather conditions experienced during the winter of 1941/42. Chapter IV addresses the effects, or problems, caused by the winter weather upon ACV's. The problems experienced by both forces were categorized by those attributable to cold and those to snow.

Chapter V discusses the solutions to the problems encountered and analyzes the impact of the problems upon German and Soviet ACV operations. Chapter VI summarizes the

findings and tenders the author's conclusions. The significance of this study upon doctrine and materiel is discussed, and suggestions for further research are provided.

ENDNOTES

CHAPTER I: INTRODUCTION

1. United States Military Academy, The War in Eastern Europe (June 1941 to May 1945) (1952): 45.

2. Ibid. : 8.

3. Staff of Strategy and Tactics Magazine, War in the East, The Russo-German Conflict, 1941-45 (1977): 167-168.

CHAPTER II

SURVEY OF LITERATURE AND METHODOLOGY

> Anyone can bear severe cold as long as he knows that he can get warmed up again. But if there is no such prospect, as with the troops in this stage of the war, the cold can be terrible.
>
> General F.M. von Senger und Etterlin in Neither Fear nor Hope

Survey of Literature

There has been much written concerning the Russo-German conflict on the eastern front. The objective of this section is to provide a review of the literature concerning the operation of ACV's by the German and Soviet forces during the eastern front winter campaign of 1941/42.

Before beginning to address the literature categories, the reader may benefit from a short discussion of limitations that exist with respect to the research of winter warfare operations. The two main limitations are arctic vesus non-arctic winter warfare and mechanized vice non-mechanized operations during winter warfare. Although not impediments to the study project, they did provide finite boundaries for the research effort.

Winter warfare is often confused, or considered to be synonymous, with arctic warfare. Such is not the case. Arctic warfare concerns those military actions which are

conducted within the territorial limits of the arctic circle. Arctic warfare may occur in the winter or in any other season; winter warfare always occurs in the winter, either within or outside of the arctic circle. Some conditions prevalent in a Russian winter may be as severe as those experienced in arctic environs, however, the effect of those conditions upon military operations is different due to terrain, infrastructure, lines of communication, etc. Generally speaking, arctic warfare is a specialized type of action requiring mission-peculiar materiel, organization, and doctrine.

The eastern front's 1941/42 winter campaign was the first campaign in which large numbers of mechanized forces participated in winter warfare. It is essential to recognize that even though large numbers of German and Russian mechanized forces were committed, the vast majority of the forces employed were not mechanized or motorized.1 Much of what has been written concerning winter warfare on the eastern front centers on the personnel aspect, i.e., what were the problems faced by the infantry soldier and how did he stand up? Though these works are important contributions across the broad spectrum of winter warfare, they do not provide information pertinent to the problems of mechanized operations.. Their relevance lies more in the area of the winter's impact upon application of a nation's war-fighting doctrine.

As stated at the beginning of the chapter, this survey will generally address categories of literature from a collective standpoint rather than discretely addressing individual sources. The reader is left to draw his own conclusions concerning source materiel relevance and coverage of the topic based on the reference and context endnotes at the end of each chapter. Furthermore, only those sources written or translated into English were used.

Within the major category of books, it suffices to say that none were found which exclusively addressed the conduct of winter warfare or the effects of the cold and snow upon ACV's during this campaign. On the contrary, few were found which did not address the winter warfare aspect in some way, albeit if only to discuss personnel, as opposed to materiel, problems and impacts. Notable exceptions to this trend were James Lucas's War on the Eastern Front, 1941-1945: The German Soldier in Russia; The Russian Campaigns of 1941-43 and 1944-45 by William E.D. Allen and Paul Muratoff; and Albert Seaton's The Russo-German War, 1941-1945. These books provided considerable information with regard to mechanized winter warfare and ACV operations.

By far the greatest contribution of the books used was to provide an overview of the conflict and also to assist in focusing subsequent research via bibliographical sources. Many of these sources were invaluable in "setting the stage" for the campaign and assisting in gaining an

appreciation for the scope of the conflict. Although the treatment of the campaign was normally at the strategic and sometimes operational levels, tactical operations were also discussed. Excursions down to the tactical level generally tended to highlight a particular point the author wished to make. Specific battles were discussed insofar as they contributed to the understanding of why or how a campaign was waged.

A superb primary source of information was the Foreign Military Studies series. Immediately after the end of World War II, a program was begun under the auspices of the Historical Division, Headquarters, European Command, to question German general officer prisoners of war on different aspects of the conflict. Fortunately for this study, the range of topics was broad and covered the eastern front as well as the European theater of operations. The effects of the Russian winter upon combat operations were addressed in many of the resultant manuscripts. These manuscripts provided a wealth of detailed information about combat operations during this campaign. Differing perspectives were gained due to the diversity of the conditions on which the authors based their conclusions.

One of the limitations discussed previously was readily apparent with respect to the manuscript collection: the impact of winter's elements upon mechanized operations was a relatively small part of the total treatment of winter

warfare. Nonetheless, valuable information concerning problems encountered by ACV's and impacts thereof was contained in several manuscripts. Additionally, the topic coverage drew from not only the mechanized force commanders, but from combat support and combat service support leaders as well as high-level staff general officers. Particularly useful were the manuscripts of Generalmajor Oskar Munzel, "Tactical and Technical Specialties of Winter Warfare", and Generalleutnant Fritz Wentzell, "Combat in the East: Experiences of German Tactical and Logistics Units in Russia".

Government publications were also a very good source of information. The U.S. Army has done a considerable amount of research and publication of works dealing with the eastern front conflict. Although most of that effort was conducted and completed within ten years after the end of the war, the results are still valid and useful from a historical perspective.

For several years after the war, the Department of the Army conducted an extensive program to categorize the eastern front campaigns and battles by functional areas. The result was a series of pamphlets which addressed how the combatants conducted combat operations in different functional areas. Some of the functional areas included winter warfare, small unit actions, combat methods, maintenance procedures, etc. Much of what the pamphlets

cover deals with the German experience; coverage of Russian operations in these pamphlets was based on German reports.

The source of information for this pamphlet series were the manuscripts which resulted from the European Command Foreign Military Studies series. Each pamphlet was a collection of functionally-related manuscripts consolidated into a single document. Based on the manuscript information, a conclusion section was normally included which consisted of the lessons-learned aspect for that functional area. However, since they were a compilation of multiple reports, the pamphlets often failed to provide the level of detail found in the manuscript series.

Although details may have been missing with respect to a particular event or action, the pamphlets provided a valuable source for cross-referencing. Pamphlet entries which were relevant to the winter's effects on ACV's, but lacked necessary detail, were used as a basis for cross-referencing a search back into the manuscripts. This effort was time consuming and not always successful, however, the payoff associated with success outweighed the burden of the search.

Another very useful government publication on this subject was the German Winter Warfare Handbook. This handbook was prepared by the German Army as a result of the 1941/42 winter campaign. It was a primer for German troops

on how to retain combat effectiveness during the Russian winter. Although the bulk of the information pertained to non-mechanized forces, there was substantial coverage of solutions/improvisations which were relevant to ACV's. This handbook was an excellent source of information. The handbook was captured by the allies during the war, translated, and published by the War Department in 1943, with a subsequent reprint in 1983 under the same title.

The final government publication which merits some attention is Allen Chew's Fighting the Russians in Winter: Three Case Studies. This document was prepared as one of the Leavenworth Papers, a historical series sponsored by the Combat Studies Institute, Fort Leavenworth. This publication is a brief, articulate, well-documented study of winter warfare in Russia. It was very beneficial in helping to focus the research effort at the outset.

Military and defense related periodicals provided a valuable source of information, especially for the Soviet conduct of mechanized winter warfare. With respect to articles on this subject, several trends became evident. First, during the conflict on the eastern front, accounts of the campaigns and battles were cabled from the United States embassy in Moscow to the State Department. These accounts, which often included tactical and operational techniques and lessons learned, were provided to appropriate U.S. Army service schools for inclusion into their curriculum or for

publication in service or branch journals, as appropriate. The accounts of mechanized operations were found mainly in The Cavalry Journal. Both wartime and post-war editions contained considerable first-hand information on the Russian experience.

Most of the wartime periodical coverage of German mechanized actions on the eastern front was from Russian sources (and provided to the United States embassy in Moscow), or from allied observers in Russia during the conflict. The preponderance of articles concerning the German experience in this campaign was written after the war by German officers who served on that front. The Marine Corps Gazette was a good source of information with respect to German wartime accounts of ACV actions, particularly at the tactical level. An extraordinary article, highly recommended to the reader, is Lieutenant General Fritz Bayerlein's article, "With Panzers in Russia 1941/43", found in the December, 1954 edition of the Gazette.

From a different standpoint, the Military Review was also an excellent source of accounts of ACV operations. The articles in this periodical tended to focus more on the operational and strategic considerations of the eastern front battles and campaigns than on the tactical, unit-level "how-to-fight" issues. Occasionally, however, articles were published dealing with the conduct of winter mechanized

operations at the small unit level. Many of such articles were translations from other nation's service journals.

Commercial, non-military periodicals provided very little information. Most of those reviewed concerned personal accounts of some aspect of a campaign or battle. A common thread among these articles was an emotional approach to the subject; the few German accounts reviewed tended to focus on the hardships endured, while the Russian articles espoused the virtue of personal sacrifice for the good of the state. This area was essentially worthless as a source of information.

No theses or dissertations were found directly relating to the effects of winter weather upon ACV's. An index review revealed several theses which appeared might have an indirect relationship to the topic. However, after review, only one thesis was found to be applicable. Major William G. Cash's "Northern Offensive Operations" thesis provided information of a generalized background nature.

A word of caution is in order concerning the reliability of the Soviet-derived information. Throughout the conduct of the research, most of the German information concerning problems, solutions, and impacts was corroborated by other sources. The German accounts were generally straightforward, permitting the researcher to assess cause and effect. Not so as regards the Soviet experience.

A dichotomy existed concerning the reliability of the Soviet sources. The reports and accounts generated during the war and soon after its completion (one to two years) were considered relatively accurate. Many of those accounts corresponded with later German reports. Additionally, when ACV design differences and doctrinal/organizational differences were considered, divergencies could be rationally explained and the reports appeared factual.

However, many later accounts were contradictory in nature to previously published reports. Whereas earlier reports acknowledged winter-induced ACV problems and impacts, later accounts tended to reverse that position. The later accounts played down the effect of the winter conditions upon ACV's and winter warfare in general. The premise purported in these later accounts was that the inherent superiority of the Soviet soldier and his equipment was solely responsible for the victory achieved. Later accounts reported the weather conditions to be considerably milder than earlier Soviet and German reports. A predominant common theme was that all Russian reversals experienced during this campaign were caused by adverse weather conditions while the same conditions had no effect upon German operations.

Methodology

This study was conducted using historical research methods. Traditionally, histories have divided the conflict on the eastern front into distinct campaigns, the number of which ranged from five to seven depending on the author consulted. Campaigns were generally delineated by seasonal and operational (offensive/defensive) considerations. This study centers on the first winter campaign, October, 1941 through March, 1942. As stated earlier, this winter period was the most severe experienced on the eastern front with respect to the conditions present.

Within the stated winter campaign period, the focus of the research effort was on mechanized operations and the effects of the winter elements upon ACV systems. For purposes of this study, the adverse winter elements were categorized as cold and snow. The effects of each were treated as distinct problem sources although occasions arose when both elements were simultaneous contributors to the problems encountered. In those cases, the problems were arbitrarily ascribed to either of the elements and discussed accordingly.

The research effort consisted initially of identifying specific problems for ACV's caused by winter conditions. Soon however, another technique for conduct of the research appeared desirable. It was found that some

sources discussed solutions without discerning the problem. Other works related that certain actions or operations could not be accomplished (impact), but did not discuss why. What evolved were three distinct research entry points: problems and effects, solutions, and impacts.

Once this triad was identified and formalized, the research effort continued. Essentially, three lists were developed. Pertinent data was then assigned to one of these lists. The lists were cross-referenced to determine problem-solution-impact relationships and continuity. The cross-check afforded by this procedure helped to establish the corroborative validity of factors. That some reported problems did not have a solution in no way invalidated the problem. Several problems experienced by ACV's as a result of the winter conditions were not capable of being solved either by improvisation or by near-term technical action, i.e., before the next (second) winter campaign. The reader will find discussion to that effect in the appropriate chapters.

The preponderance of the research effort continued until the growth rate of the categorized listings dropped significantly and soon stabilized. The research effort has continued through this writing, although at a significantly reduced level.

Except where noted, this study addressed only those problems/effects for which adequate substantive data existed

to reasonably assume validity. Exceptions to this procedure were based on the significance of the factor(s) or the paucity of evidence to refute validity.

ENDNOTE

CHAPTER II: SURVEY OF LITERATURE AND METHODOLOGY

1. As the central battle during this campaign was the Battle of Moscow, it is interesting to look at the German Army Group Center order of battle to appreciate the mechanized to non-mechanized force ratio. The drive on Moscow began in early October. At that time, Army Group Center consisted of sixty-nine divisions, of which fourteen were mechanized and seven were motorized (wheel transport). Thus, from a purist's viewpoint, the mechanized forces comprised only twenty percent of Army Group Center's divisional strength. If the motorized divisions are included, the ratio rises to thirty percent. At the same time, Army Group North had only two of twenty-six divisions mechanized (eight percent) and Army Group South had four of fifty-five divisions (seven percent). USMA, War in Eastern Europe: 44.

CHAPTER III

SYNOPSIS OF THE FIRST WINTER CAMPAIGN, 1941 - 1942

> On the next day, 7 November, the traditional parade of Red Army troops was held in Moscow. ...Snow had fallen the night before... It froze.... A sharp cold wind was blowing. Winter, which the German aggressors awaited with fear, came with its own laws.
>
> History of the Great Patriotic War of the Soviet Union.
> Yu. P. Pretrov,Editor

Synopsis of the Campaign

In late June, 1941, the German Army launched operation "Barbarossa" - the invasion of the Soviet Union. German military planners, both at the Armed Forces High Command (OKW) and the Army High Command (OKH), estimated a campaign of about five to six months duration. Their planning assumptions included a start date of mid-May, defeat of Soviet forces by November 1941, and a stay-behind occupation force through the winter of 1941-42 consisting of approximately one-third of the German operational strength in Russia at the end of the campaign.1 These assumptions proved to be ill-founded and later haunted the OKW and OKH staffs.

Nevertheless, the German invasion was underway. The German Army attacked on a broad front, organized into three

groups: Army Group North, Army Group Center, and Army Group South (See Figure 1). The operational plan called for these armies to attack into the depth of the Soviet Union using three parallel axes. Army Group North was under the command of Field Marshal Ritter Von Leeb. Its objective was the city of Leningrad and the securing of the Baltic States. The group of armies in the center was led by Field Marshal Fedor von Bock. Army Group Center was to secure Moscow, the Russian capital, via the city of Smolensk. In the south, the objective was the city of Kiev. Army Group South was commanded by Field Marshal Gerd von Rundstedt. Army Group North consisted of two infantry armies and one panzer group (the term "group" used when associated with tank units rather than "army"). In early fall, the panzer group was transferred to Central Army Group to support the Moscow effort. Army Group Center was initially comprised of four armies, two of which were panzer groups. In the south, Field Marshal von Rundstedt had two infantry armies and one panzer group. The separation of the tanks into distinct panzer groups was a result of the German Army's belief that the great success in Poland and France was due largely to this type of employment.

It must be kept in mind that given these force dispositions and territorial goals, the main German objective was the destruction of the Soviet Union's armed forces and military resources. From an operational

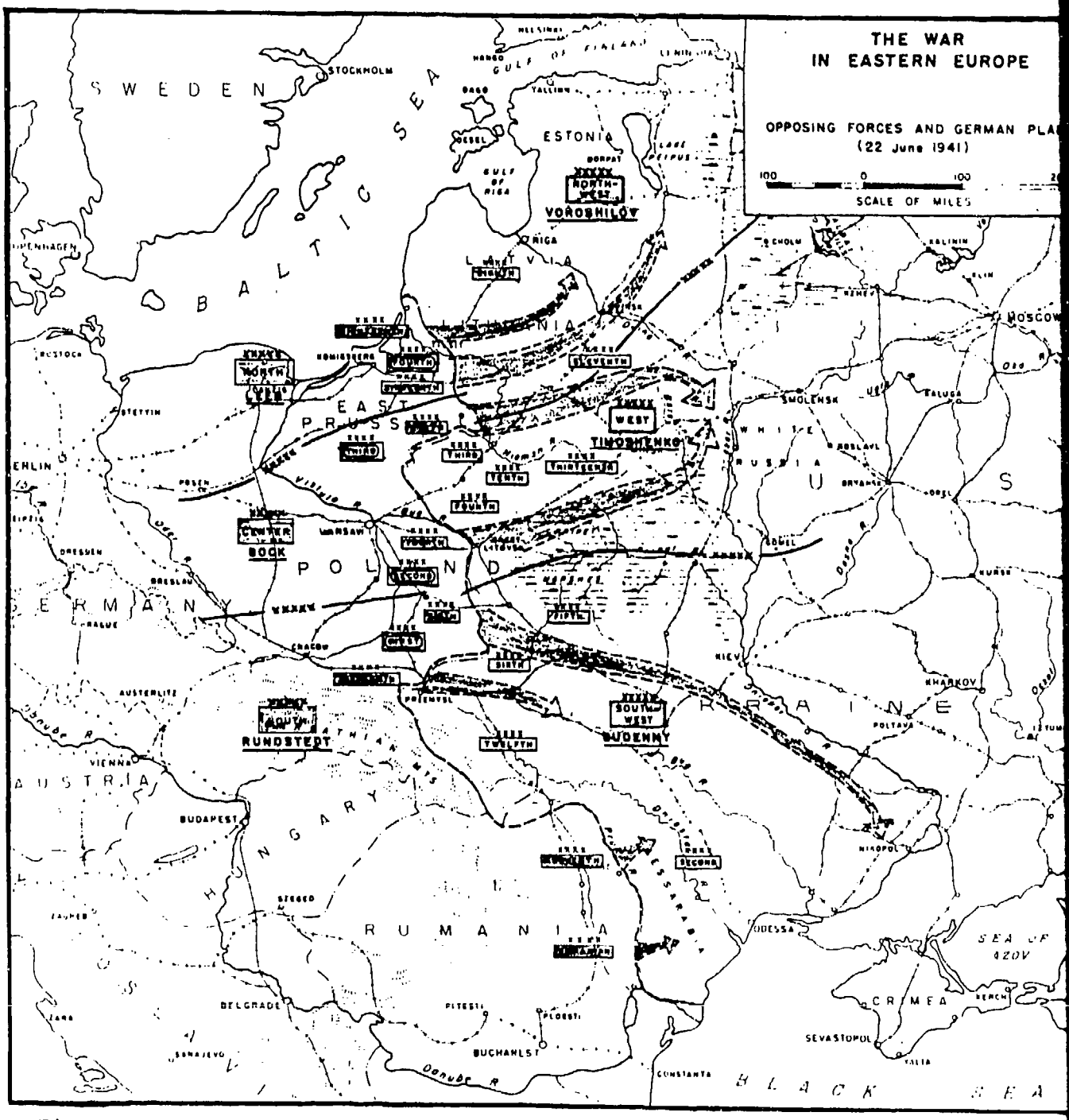

Figure 1. German and Russian Dispositions, June, 1941

Source: USMA, The War in Eastern Europe

standpoint, the German order of battle and assigned territorial objectives supported the main objective.

At the time of the invasion, the Red Army was organized into three Army fronts which were, like the German's, geographically oriented, (See Figure 2). The Soviet "front" equated to a German "Army Group". The Northwest Front was commanded by Field Marshal Kliment Voroshilov, the Western Front by Marshal Semen Timoshenko, and the Southwest Front by Marshal Semen Budenny. Each front included two or more armies; the dispositon of armies and divisions within the fronts varied greatly from battle to battle. Altogether among the three fronts there were some 158 infantry divisions and over 50 tank brigades.

The objective of the Soviets was to delay the German advance to the greatest extent possible in order to gain more time to mobilize both personnel and industry. The bulk of the units raised from the reserves during the first several months following the invasion were organized into divisions and kept in the interior, awaiting adequate equipment and supplies before being committed. On the other hand, some units, brigade and regiment size, were equipped and then immediately committed to plug gaps in defenses. Soviet troop disposition and task organization during the early months of the conflict were largely a reaction to German initiatives.

From June through September 1941, the German juggernaut moved east. The greatest advance was made by von Bock's Central Army Group, which was the main German effort. Army Group Center had captured Smolensk by 7 August; forward elements were less than 200 miles from Moscow, and over 800,000 Red Army soldiers had been taken prisoner. In the north, von Leeb had advanced rapidly. Leningrad was surrounded by early September. Because the city would not fall, the Germans decided to lay siege while consolidating local gains. In the southern sector, Army Group South had been slowed by extensive, prepared positions and greater Russian troop strength than expected. Strong Russian resistence had been met throughout the advance. Army Group South's inability to secure Kiev had slowed up Army Group Center's advance from Smolensk; Kiev had to be secured so that the Central Group's southern (right) flank would not be vulnerable as it moved east. It was not until the end of September that Kiev was encircled and captured. The almost two month delay in advance in the central sector gave the Red Army time to reorganize and improve the defenses west of Moscow. As the German attacks were pressed in the central and southern sectors, the Russians continued to trade space for time. The Red Army considered winter to be their closest ally. If they could hold on until mid to late November and retain key cities (i.e., Moscow, Leningrad), they believed the winter conditions would bring the German

attack to a halt. Once the Germans stopped, they would then have the right conditions to launch a counteroffensive to push the Germans back and, more importantly, to attrit their limited manpower resources.

It was not until the end of August that the OKH accepted the possibility of having to fight on through the winter. Much of the staff thought that the victory at Kiev by Army Group South ensured the fall of Moscow and subsequent wintering of the Germans in Army Group Center at that location. It was at this time that the first request for winter clothing, other than that planned for occupation forces, was forwarded.

In September 1941, Hitler, at that time the Commander-in-Chief of the German armed forces, changed his August decision concerning the objective of the German advance in Russia. He now revived the OKH plan to capture Moscow, believing that von Rundstedt's Army Group South would be able to continue on towards the Caucasus without any support from von Bock's Army Group Center.
Additionally, the static siege of Leningrad permitted Army Group North to release its Fourth Panzer Group to provide additional combat power for Army Group Center's advance on Moscow. The Battle of Moscow was essentially a series of battles fought in a fixed frontal sector. It was one of the most decisive of the war.

In support of the Battle of Moscow, the first phase of this winter campaign, the Germans amassed in Army Group Center almost one half of the personnel and equipment available in the theater of operations. Army Group Center's troop list at the beginning of the campaign consisted of the Ninth, Fourth, and Second Armies, plus the Second, Third, and Fourth Panzer Groups. The Second Panzer Group consisted of five panzer divisions, four motorized infantry divisions, and seven infantry divisions; it was at only 50 per cent of normal combat strength. The Third Panzer Group consisted of three panzer divisions, two motorized infantry divisions, and seven infantry divisions; it was at seventy to eighty per cent combat strength at the beginning of October. The Fourth Panzer Group consisted of six panzer divisions, one motorized infantry division, and four infantry divisions; it was in excess of eighty per cent strength, with four panzer divisions at full strength.[2] Together, these armies and panzer groups made up 75 divisions, including fourteen tank and seven motorized divisions. The tank and motorized infantry strength was slightly over two-thirds of that employed on the eastern front.

The panzer strength figures were a significant improvement to that reported at OKH just thirty days prior. OKH had reported that, effective 4 September 1941, only forty-seven per cent of the tanks in the Russian theater were available for employment; twenty-three per cent were

non-operational for repair activities, while thirty per cent were considered as combat losses.[3] The improvement of Army Group Center's tank readiness posture was due largely to tanks being repaired at a greater rate than being lost (i.e., the lull after Smolensk). Of note is the fact that the First Panzer Group, Army Group South, was at approximately forty-seven per cent strength at the beginning of September, but was severely weakened by the Kiev operation; in mid-September, a panzer division of the group reported only ten serviceable tanks available for action.[4]

The remaining troop strength within the theater consisted of Army Group North with twenty-six divisions (two panzer, two motorized, and twenty-two infantry), and Army Group South with fifty-five divisions (four panzer, one motorized, and fifty infantry or mountain).

Soviet troop dispositions had changed somewhat. The Soviet main line of resistance was the Western Front protecting Moscow. Veteran Red Army units that had been defending during the summer and into the autumn continued their delay eastward across the entire theatre. Because of the siege of Leningrad and subsequent slowing of operations in that sector, some combat forces had been transferred to the Western Front to help shape up the defenses in front of Moscow. The Southwest Front was in much the same condition as the Western Front. It too had been attrited heavily, and had lost a great number of soldiers to encirclement at Kiev.

The Soviet High Command (STAVKA) was following a policy of reconstituting front line forces on a piecemeal basis, dependent upon where the threat was the greatest with respect to German penetrations. STAVKA refused to let short term losses of an operational nature influence their long-term strategic plans of a winter counteroffensive. In mid October, German intelligence at Army Group Center estimated Soviet Western Front strength to be twelve armies consisting of some ninety understrength divisions.[5] (See Figure 2). Given this strength estimate, the Germans had good reason to believe that their plan of capturing Moscow via a double envelopment by the panzers would succeed. Unknown to OKH, by early December the Red Army would concentrate over forty per cent of its front line manpower and thirty-five per cent of its armored combat vehicles (ACV's) and combat aircraft for the defense of Moscow.

> On 2 October, 1941, Hitler addressed some of his forces readying for the final attacks on Moscow: In three and one-half months the necessary prerequisities have been created to crush the enemy, by means of a powerful attack, before the onset of winter. All preparations that were humanly possible have been completed.[6]

Thus, the Battle of Moscow began. The battle was to be the centerpiece, the almost exclusive focus of both belligerents over the next few months.

The first snow fell on 7 October, earlier than normal for the Moscow area. With foresight, Gen. Heinz Guderian's Panzer Group sent an inquiry to Army Group Center on winter

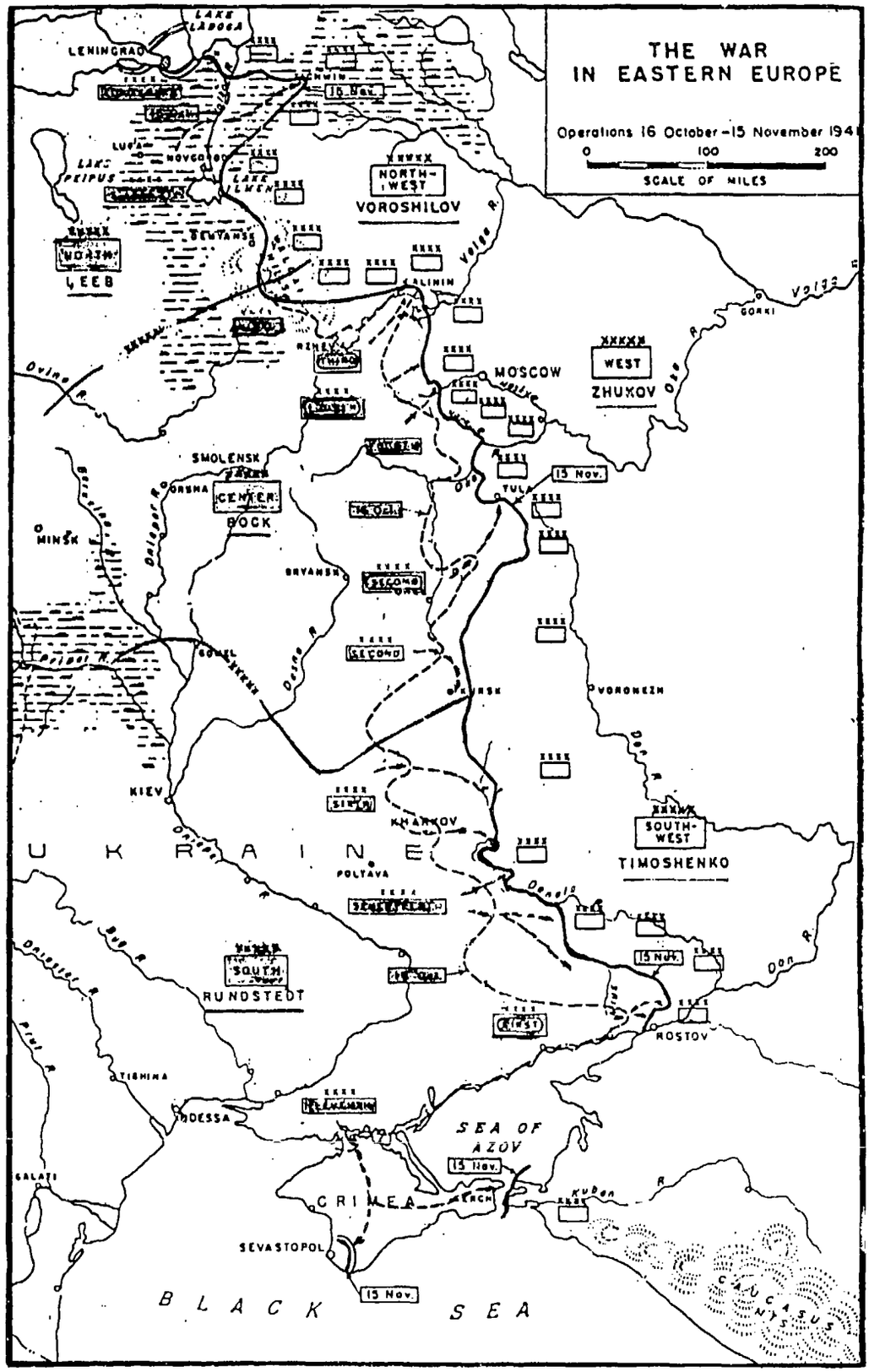

Figure 2. German and Russian Dispositions, Oct-Nov

Source: USMA, The War in Eastern Europe

clothing. He was told he would receive it in due time and not to make anymore unneccessary requests of that type.[7] Throughout October the German forces advanced east at a great toll of lives and equipment. The night frosts enhanced trafficability during the mornings. After the midday thaw set in, operations slowed considerably or were limited to roads.

A distinct pattern of combat emerged. The German panzer units would make substantial advances. The Red Army forces would then counterattack before the German infantry arrived to consolidate the gains, forcing the panzer units to yield the ground they just captured. The panzer actions on the flanks were more successful than the predominantly infantry attack in the center of the zone. This was because the infantry forces lacked mobility and were thus forced into bludgeoning away frontally at well-entrenched, heavily defended Soviet positions. The flank panzer units enjoyed a mobility advantage over the Soviets due to the skill of their commanders, tank-mounted radios, and night freezes providing excellent off-road mobility for a part of the following day. The panzer group in the north was particularly adept at outmaneuvering its Russian opponents. The panzer group on the southern flank of Army Group Center faced a more heavily defended zone and advanced somewhat slower, though still outdistancing the infantry units on its left (See Figure 3).

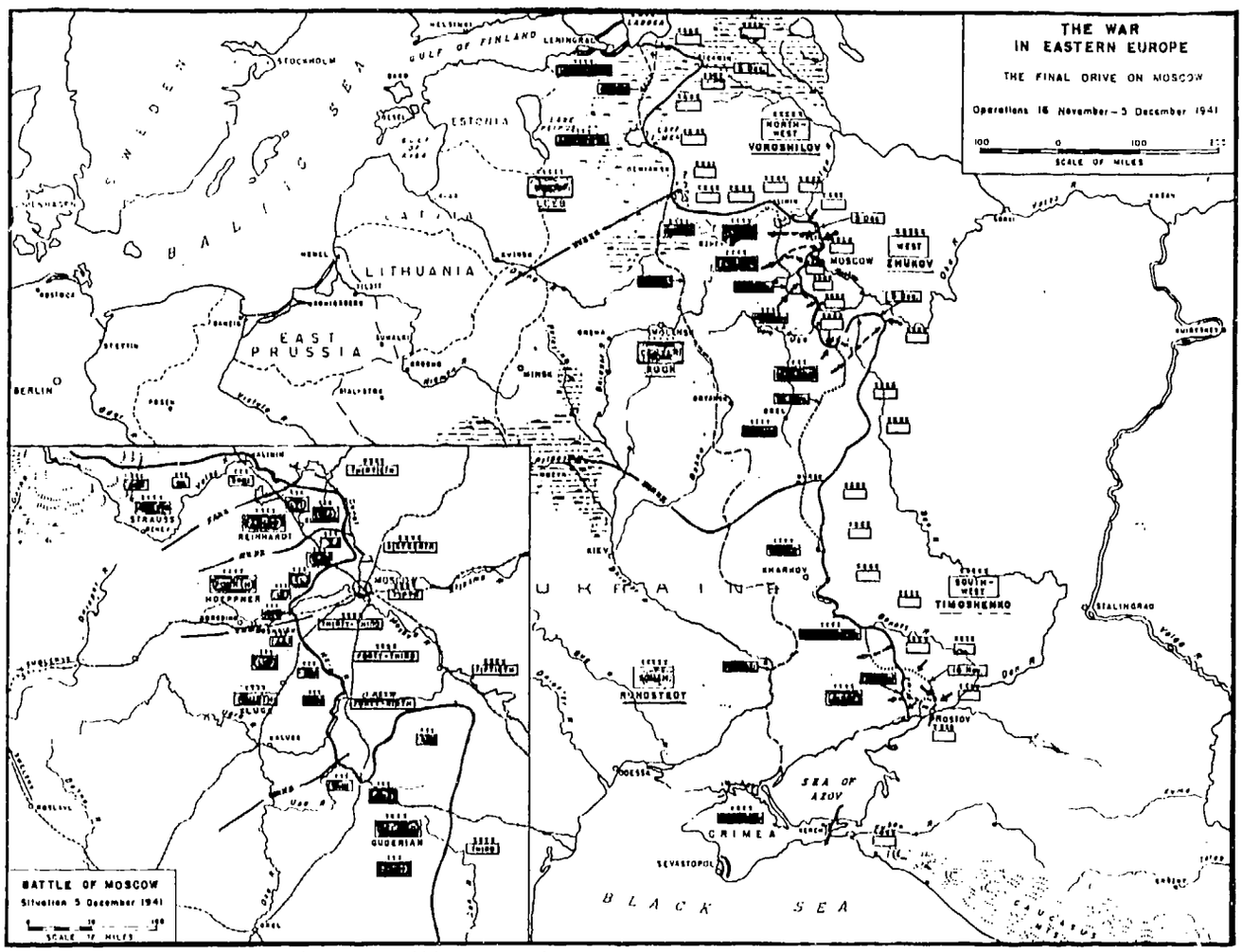

Figure 3. German and Russian Dispositions, Nov-Dec

Source: USMA, The War in Eastern Europe

In the Red Army, commanders had changed also. Marshal Budenny had been relieved of command. Marshal Timoshenko was shifted to the Southwest Front. Marshal Georgi Zhukov was placed in command of the Western Front in early October.

By early November, there was concern among the Army Group Center staff and line commanders about the progress of the attack on Moscow. The concerns were in several areas. First, the Russian resistance was not crumbling as it had before. It was in fact getting stronger. The Germans were identifying more new units of regiment, brigade, and occasionally division size committed by the Red Army to the defenses. This was also the first appearance of Russian reserves in any great numbers, organized into large, self-sustaining combat units.

Additionally, the Russians began to employ the new T-34 tank, in numbers, with considerable effectiveness. The T-34's mobility and heavy armor made it more than a match for any German tank of the day. The only weapon system that could defeat it regularly was the eighty-eight millimeter anti-aircraft gun used in direct fire anti-tank role. The eighty-eights were in short supply at that time, however. For panzers to be effective, they had to get within close range and outnumber the T-34's.

Another concern was that the operational readiness of German tank and mechanized units was alarmingly low. By 6

November, the OKW reported that only six per cent of the tanks on the eastern front were combat effective.[8] This amounted to slightly under two hundred tanks. The vast distances covered by the invasion put a great strain on all vehicles, but on ACV's in particular. The ACV's had to move everywhere under their own power. In Russia, this meant great distances, far exceeding that experienced in France or Poland. After several months of fighting, many of the ACV's were in bad condition and needed repairs. The previously mentioned lull in the fighting for Army Group Center in August and September helped immeasureably in getting repairable equipment fixed and back to the frontline units. It did not accomodate replacement of ACV's completely destroyed in battle; weapon system replacements were slow in coming, if at all.

Powertrain components, track, and turret components, such as turret drives, were damaged and worn by the conditions they had been exposed to, particularly the never-ending dust of summer. The supply of spare parts was so scarce that some units resorted to sending selected maintenance and supply personnel back to the vehicle and part factories in Germany to scrounge critical components by any means possible. The Germans were to conduct the most important campaign to date in the war with Russia short of weapon systems, particularly ACV's, and with less than optimum effectiveness of those on hand.

The last concern was the weather - the Russian winter. By early November, cold weather had set in without the normal transition period from the muddy season to winter. It was about a month early. The concern centered over the Army's preparedness for winter, both for men and equipment. German commanders were sometimes hesitant to launch offensive operations in the face of the deteriorating weather conditions. As a result, opportunities for advance were lost or made more costly.

Thus, at the beginning of November, there was probably a moment of serious doubt among the German commanders as to the advisability of entering into a winter campaign with armies unprepared for winter conditions. A decision could only be taken by Hitler.[9] OKH called a Chief of Staff conference at Orsha on 12 November 1941. The purpose of the conference was to announce the decision for what the winter campaign would be, i.e., a defensive or an offensive campaign. The orders announced by the OKH Chief of Staff, Gen. Franz Halder, were to continue the advance on Moscow. The decision to continue on to Moscow was made by Hitler late in October. Given the situation of late October, it appeared to have been a rational decision. However, the situation at the front was deteriorating rapidly and by mid-November, the validity of that decision became more questionable. The impact of weather at that early date, both in terms of its early onset and harshness,

was having a worse impact on soldier morale and efficient working of equipment than anticipated.

With that direction, the offensive continued. New objectives were assigned by Hitler through OKW and OKH. Army Group Center's ability to synchronize its operations became more and more difficult, allowing the Soviet defenders greater flexibility. On 24 November, Gen. Guderian was summoned to Army Group Center headquarters to explain why his panzer group's offensive was late in starting. Gen. Guderian explained the delays, mostly weather related, and protested to Field Marshal von Bock that he not could accomplish his newly assigned mission - the capture of objectives some two hundred miles east of Moscow. The matter was taken to Gen. Walter von Brauchitsch, Commander in Chief, OKH, who decided that the attack must begin but with more limited objectives. Army Group Center made progress, particularly on the flanks, until about 1 December, when the entire offensive started to wither. The primary cause of the reversal was the sudden arrival of extremely cold temperatures, plummeting as low as minus forty degrees Fahrenheit. As frostbite produced more casualties than enemy action, the offensive was halted by its own lack of progress.

The turning point was reached in accordance with Soviet plans. Marshal Timoshenko and General Zhukov described the Red Army plans for the winter of 1941-42:

> Hitler's statement at a session of the Reichstag on 9 October has served to inform us that the German command is determined to stage an offensive against Moscow. This means that the major part of German materiel will be concentrated around our capital. The winter will facilitate our conduct of operations and will enable us to take the initiative. Before Moscow, we certainly will be offered an opportunity that must be exploited under all circumstances. By its almost adventurous and otherwise incomprehensible actions, the German command has incurred the grave risk of seeing every last piece of its motorized equipment put out of action with the first sudden turn in the weather.. According to our intelligence, the Germans have no cavalry in the established sense of the word. Their entire strategy is based on mechanized cavalry. For the time being we must hold our lines for as long as we can, but as soon as several days of severe cold have broken the backbone of the German offen ive, we must immediately go over to the attack. The backbone of the German offensive are [sic] tanks and motorized artillery, which can no longer be employed at a temperature of - 20 degrees Centigrade (C)(-29 degrees Fahrenheit). Zhukov will attack as soon as several days of severe cold have made it safe to assume that enemy mobile operations have become impossible. Our main objective is to destroy the enemy's materiel.... Once we have deprived the Germans of the use of their materiel, once we have them on the run, the winter will finish the job.[10]

By nightfall on 5 December, the German attack had faltered in the Army Group Center zone. On 6 December, the Red Army's counteroffensive began. It had been thoroughly prepared. During the defensive periods of the previous months, the reserve units formed to support it had been carefully husbanded and held in readiness. The moment was skillfully chosen - just when German success seemed outwardly at its climax, though the real offensive power of the German Army had already been exhausted, and just when

cold weather began to make German tank operations more difficult.[11]

Materially and tactically, the Red Army was thoroughly prepared for winter warfare. Its supply and transport systems and its combat methods were adapted to the conditions of the winter campaign.[12] Within just a few days, the armies of Army Group Center had been separated from each other and were fighting autonomous battles, not knowing what was happening on the flanks.

The counteroffensive was not a central battle in a fixed sector. It was a series of battles along the entire theater front line. The three fronts which had been pushed back across the plains of Russia suddenly expanded to eight fronts. Army Group North was opposed by two fronts, (Leningrad and Volkhov) and a part of a third (Northwest); Army Group Center was now opposed by part of one front (Northwest) and two others to the south (Kalinin and and West); Army Group South was opposed by three fronts (Southwest, South, and Caucasus). The preponderance of the combat power was centralized in the Kalinin, West, and Southwest Fronts (See Figure 3). The exact number of units committed to the counteroffensive was not specified although it is believed to have far outnumbered the operational and strategic reserves held by the Germans. The greatest advances were made by the fronts in the vicinity of Moscow,

creating many salients and pushing back the German lines as far as one hundred fifty miles to the west.

Two significant factors developed during the course of the Soviet counteroffensive. The first was Hitler's order to hold positions in place rather than allow front line units to delay back to a more contiguous front line trace. The order to hold present positions created the necessity for the Germans to conduct a strongpoint or "hedgehog" defense, and subsequent battles of encirclement. Though faced with enormous difficulties, the Germans executed that type of defense well. The order to hold in place was likely the main reason that the German defenses stretched, but did not break. A wholesale withdrawal across theater lines could have easily resulted in a complete rout of German elements. These defensive skills, so aptly applied in encirclement and breakout operations during this winter campaign, would return under different conditions to betray and doom the German Sixth Army at Stalingrad.

The second factor was the conspicuous absence of large German tank formations so prevalent up to that point. The main reason for this was the tremendous losses suffered by the mechanized forces of both belligerents. The violent tank battles of the summer and fall of 1941 were sometimes fought on a huge scale. If in the early period of the campaign the Russian tank losses exceeded the German, the score was more or less evened up during the October and

November German offensives, which were stopped at the gates of Moscow.13

For over three full months the German forces were on the defensive. The "hedgehog" tactic ordered by Hitler had a strategic effect. By ordering his armies to stand in place he ensured the retention of most key communications and transportation centers. The Russians achieved only limited success in the northern and southern sectors with the greatest gains being made where they wanted it the most, near Moscow. By March 1942, the onset of the muddy season, both forces were spent due to the continuous and fierce winter battles. The Battle of Moscow and the subsequent Russian counteroffensive were the major actions of the winter campaign of 1941/1942.

Weather Conditions Experienced During the Winter of 1941-42

The only certainly which can be stated about a Russian winter is the uncertainty of its severity. The popularly conceived notion of a vast white wilderness immobilized under a heavy blanket of snow for more than one-half of the year is an exception rather than a rule. The immense size of the Soviet Union lends itself to considerable variances in weather conditions throughout the country. For purposes of this study, only the military area of operations of the Russian-German conflict will be examined with respect to winter weather conditions. In

general, this area consisted of the entire Russian land mass west of the Ural Mountains, the traditional demarcation line between European and Asiatic Russia, from vicinity of the Baltic Sea in the north to the Black Sea in the south.

In European Russia south of the Arctic Circle, winter generally lasts five to six months. Harsh winter conditions (snow, ice, cold), which hinder combat operations, can come as early as December and stay until April. The amount of snowfall varies, but as a general rule, is deepest/greatest in the northern and central regions. Winter snow depths of three to four feet are common in northern and central Russia. Waterways south of Leningrad in the northern and central parts of Russia often freeze over by mid-November, and temperatures may fall as low as minus forty degrees Fahrenheit on a consistent basis. Even during mild winters the mercury will drop to minus twenty degrees Fahrenheit.[14] Except for the extreme southern part of the country near the Black Sea, the winter conditions generally varied little and were longer and more severe than that experienced in Western Europe. It is interesting to note the effect of water and air currents upon prevailing winter conditions; the average temperature of Leningrad in January, far to the north but warmed by sea currents, is traditionally about four degrees warmer than that of Stalingrad, hundreds of miles to the south but influenced by cold Siberian winds blowing in from the northeast.

The winter of 1941-42 in Russia was the worst experienced in over one hundred years. Some Soviet sources bitterly contest the German allegations that the weather, and not the Red Army, prevented the German capture of Moscow. To this end, meteorological records have been published by the Soviets which conflict with other previously published records and portray the winter as much less severe with respect to low temperatur ; than previously reported. Marshal Zhukov, then responsible for defending the approaches to Moscow, stated that during the November general German offensive the temperature on the Moscow front remained stable at fourteen to nineteen degrees Fahrenheit.[15] In another work specifically refuting German accounts, a Soviet spokesman cited these Meteorological Service records of the lowest temperature recorded, by month, for the Moscow area in late 1941: October, seventeen degrees Fahrenheit; November, one degree; December, minus twenty degrees.[16]

On the other hand, German sources reported much colder temperatures. Field Marshal von Bock, commander of Army Group Center, recorded in his war diary on 5 November 1941 that the mer y dipped to minus twenty degrees Fahrenheit.[17] Albert Seaton reported that around 24 November it was a steady minus twenty-two degrees Fahrenheit.[18] There were many other reports of extremely low temperatures to include a report by Gen. Guderian that on 10 December,

during the Russian counteroffensive, he recorded a low temperature of minus sixty-three degrees Fahrenheit.[19]

The first snow of that winter season fell on around 7 October. Intermittent snowfall occurred across the entire front for the next two months with little accumulation, or if accumulation, it was of short duration. It was not until the beginning of December that heavy snow fell and the accumulation was deep and continuous until spring. The snow that winter was generally dry and powdery and remained as such throughout the winter in most places. That was somewhat unusual since a short duration thaw normally occurred at some point during the winter in most areas, turning the snow from its dry, powdery consistency into a wetter, heavy snow, the latter of which degraded vehicular mobility. If the thaw was of long enough duration to cause a slight melt, once the cold returned, the snow surface, or the melt, froze over into an ice crust. The ice crust enhanced foot mobility considerably and in some cases supported light vehicles such as snow tractors and small Russian farm wagons known as Panje wagons or carts. The only such thaw reported was in the central sector immediately before Christmas, of only a few days duration. It had the effect of bogging down the Soviet counteroffensive in that sector.

A result of the dry snow was massive snowdrifts most frequently found in low areas. These drifts were reported

to be enormous, sometimes exceeding ten feet in depth. Narrow valleys and ravines of the plains and steppes of the central and southern sectors were very conducive to drifting; the f· ests of the north helped to protect roads traversing their interiors, though roads along woodlines were vulnerable depending on wind direction and location of the road with respect to the woods.

That this winter was characterized by heavy and continuous snowfall was not disputed. Marshal Andrei Eremenko estimated the winter's lasting snow cover in the region between Moscow and Leningrad at from twenty-eight to fifty-nine inches.[20] The snowfall south of Moscow for a considerable distance was also deep, but began to moderate considerably south of Rostov due to the warming influence of the Black Sea. Although not as severe as that on the northern and central fronts, the winter in the southern front area was still quite bitter. For example, in mid-November, the German First Army launched an attack against Rostov in temperatures of minus twenty-nine degrees Fahrenheit. Kursk was located midway between Moscow and Rostov to the south. In January 1942, the German units located about twenty miles east of the city reported heavy snowfall with high winds and deep drifts, with temperatures of minus thirty degrees Fahrenheit recorded.[21]

If the winter of 1941/42 was consistent with regard to its severity across the breadth of the theater of

operations, it was also inconsistant in some ways. The advent of winter occurred earlier than normal in 1941. Typically, snows begin in mid-November with moderate winter temperatures holding until late December; the bitter cold often arrives with the new year. In 1941, early winter frosts began in October. The snow was on schedule, however, the low temperatures arrived approximately one month early. The result of this was a shortening of the muddy season and a lessening of its impact.

The muddy season was a semi-annual event occurring at the transition from autumn to winter and winter to spring. It was characterized by continuous rain or wet snow in autumn and rain or melting snow cover in the spring cycle. The excess water turned the already inadequate Russian road network into a bottomless mud quagmire which was not negotiable by wheel and, eventually, most track vehicles. In 1941, the weather broke in mid-October and slowed down the German advance. Across the front, heavy rains and occasional wet snow combined to make cross-country routes impassable. There were, however, early frosts which froze the top several inches of soil and mud at night, thus enhancing vehicle mobility during the early morning hours of the next day until the temperture rose or vehicle traffic caused a thaw. While it is true that the muddy season adversely affected the operations of both the combatants, it

certainly was not as bad as it could have been, as the Germans were to find out in subsequent seasons.

Another peculiar feature of this winter was the arrival and chronology of the two major elements of a winter season in Russia - cold and snow. There are conflicting accounts of just when these elements supported or hindered operations and to what extent. For example, according to Generaloberst Dr. Lothar Rendulic:

> The winter of 1941/42 is memorable for unusually low temperatures and unusually heavy snowfalls. It was important that the heavy snowfalls stopped about mid-December in central European Russia. Thereafter, snowfalls were only light and sporadic. Heavy snow did not fall again until the end of January 1942. The snow on most of the roads used during military operations had already been packed so well that movement over them was possible.[22]

In contrast, William Allen and Paul Muratoff report that cold weather struck early with temperatures plummeting; nightime lows of minus forty-seven degrees Fahrenheit were recorded. Furthermore:

> In Russia, early and severe frosts always exclude any serious amount of early snowfall. And the snow, not the frost, is the principal obstacle to winter war in Russia.[23]

Both accounts agree on the fact that very low temperatures were experienced. They differ, however, on when the heavy snowfalls occurred. The latter statement is a rule of prediction rather than a historical record; it is a statement of what should happen. Historical evidence generally supports the former accounts. The first three

weeks of December were the worst in terms of having both heavy snow and the bitter cold concurrently. The collapse of the German drive on Moscow and subsequent Russian counteroffensive document well the conditions experienced throughout the front. There was heavy snow and bitterly cold temperatures. Generaloberst Dr. Rendulic's account of the periods of snowfall correllates well with the snowfall days recorded at Rzhev, northwest of Moscow, during January and February 1942: 7-9 and 12-15 January; 1-5, 7-10, 11-14, and 23-25 February. Though the lowest temperatures were recorded during periods of no snowfall, it is interesting to note that the mean temperatures during the two January snowfall periods were minus twenty-six and twenty-five degrees Fahrenheit, respectively.[24]

Another anomaly peculiar to Russian winters and terrain was the transformation of marshes and swamps. The cold temperatures would freeze marshes and swamps, often solidly enough to permit ACV traffic during extended cold periods. These same marshes and swamps became extremely treacherous when the snowfall was deep. Solidly frozen marshes, under the warming layer of a thick snow blanket, would thaw out considerably. In the northern parts of Russia, tanks often got into great difficulties while trying to negotiate supposedly solidly frozen marshes.[25] The Pripet Marshes in the central part of western Russia experienced the same phenomena.

The Russian winter of 1941/42 had a great impact upon the war due to its extreme bitterness and longer than normal duration. The impact of that winter fell upon both men and equipment. The combination of extreme cold and deep snows, both in large doses and at the same time, taxed even the Red Army soldier accustomed to the privations of a Russian winter. STAVKA had made plans for a winter counteroffensive. The bitterness of that winter was as valuable as many divisions to the Soviet strategy. The Red Army knew the winter was an ally regardless of its ferocity. The German soldier was accustomed to the milder winters of Western Europe, where particularly bad winter weather normally lasted only a few days out of the entire winter season and never came close to the intensity found in Russia. In Western Europe, shelter was always relatively close-by, so that protection from the elements was not a major consideration.

The German soldier was a product of western civilization and as such had become especially sensitive to the inclemencies of the weather.[26] No German who participated in the battles of that winter campaign had ever experienced winter conditions as harsh, over as long a period, as did Hitler's legions. The weather conditions under which the conflict was fought that winter were not seen again in subsequent winter campaigns. It is important to understand that the weather conditions in and of

themselves were not the factors which determined the feasibility of combat operations. It was the effect the weather produced, either directly upon personnel or indirectly via its effect upon what the terrain would support,which decided what was to be done.

ENDNOTES

CHAPTER III: SYNOPSIS OF THE FIRST WINTER CAMPAIGN, 1941-1942

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CHAPTER IV

THE EFFECTS OF WINTER WEATHER ON ARMORED UNITS, 1941-1942

> "Only a man who saw the endless expanse of Russian snow during this winter of our misery and felt the icy wind that blew across it, burying in snow every object in its path... can truly judge the events.
>
> Colonel General Heinz Guderian

Problems Encountered due to Weather

The harsh Russian winter of 1941/42 exposed many problems in the conduct of mechanized warfare during extremely low temperatures and deep snow conditions. The German Army, used to the relatively mild winters of Western Europe, faced more obstacles and suffered more than the Red Army. Part of the reason for that was they were unprepared for winter warfare; the General Staff planners had forecasted a six month campaign.

When in late summer it became apparent that the timetable would not be met, requisitioning started for winter clothing and equipment. It was too late to make it to the front line units in time, especially since winter started almost a month early that year. The late requisitioning, coupled with low supply priorities for cold weather equipment, caused line combat units great problems in maintaining combat effectiveness from both a personnel and equipment standpoint.

Even if planning and requisitioning had been timely, and the equipment requested made available at the onset of winter, the German Army still would have been unprepared for a winter season of the harshness and duration experienced. The cold weather equipment and ancillary items which would have been available, i.e., equipment developed as result of winter operations in Western Europe, though improving the situation, would still not have put the German Army on the same level as the Red Army with respect to its capability to conduct operations. It would have, however, alleviated much of the suffering of the German soldiers.

The lessons learned from World War I were in large measure not applicable to this winter. The eastern front of World War I was positional in nature, consisting of entrenchments and towed heavy artillery. Mechanization supported, in fact made possible, the maneuver warfare which characterized the eastern front of 1941. It also placed far greater demands upon the men and equipment.

The Red Army, accustomed and prepared for winter conditions, fared much better, although some problems were experienced. The early onset of that winter caught some units of the Western Front by surprise as they were still in their summer uniforms. The heavy snows and inevitable snowdrifts caused localized problems to mechanized forces; the intense cold influenced Soviet planning and operations, though the Russian soldier and his equipment fared better

than his opponent. The Russian's ability to endure stoically was recognized even as the winter began to unfold:

> Now a Russian winter is so severe that only the people who are accustomed to it --brought up to it, one might say --can hope to get on tolerably well. The newcomer is severely handicapped because the Russian cold is so severe that it has a remarkable effect on willpower.... Among Russian troops, this effect of temperature on the power of the brain has received considerable attention on the part of the Soviet Army authorities. For this reason, only picked men for winter maneuvers are chosen. They are not selected for their knowledge and usefulness of army routine so much as for their power of resisting cold and carrying out their duties in a normal manner.... so intense is the cold, and so remarkable the effect on willpower, that it is no uncommon thing for a soldier to forget his own name and those of his comrades.[1]

The Soviets did not have the luxury nor the resources to be able to man in excess of two hundred and fifty divisions with "selected" soldiers; it is probable that this privilege was reserved for select units conducting special operations in winter or Arctic environs.

The key point is that the author was describing the impact of a Russian winter on men who must fight in it - a typical Russian winter, not the worst one experienced in over one hundred years in Russia. The Soviets considered winter an ally. They formulated strategy around it and exploited its conditions and hardships to their advantage. The Russians did not experience the magnitude of weather induced problems that the Germans did largely because of their awareness of their own winter conditions. Problems were still encountered when weather deviations from the norm

occurred, such as long periods of extremely cold temperatures. The design of Russian vehicles included consideration of the Russian winter environment; the German design only to the extent of Western European winter conditions.

Winter warfare problems generally result from two sources - cold and snow. These factors often acted independently to cause problems for military operations. In tandem, a synergistic resulted, as was the case during December, 1941. As the complexity of the means of warfare increased, so did the impact of these factors upon operations. The relative sophistication of mechanized warfare made it particularly vulnerable to the effects of the Russian winter. The greater the reliance upon motorized or mechanized eans, the more problems that arose. Nevertheless, the Soviets did mechanize their forces to a great extent while still retaining flexibility by keeping more primitive formations, such as horse cavalry, in their armies. To provide a logical and detailed problem analysis, this study will address each of these factors separately the cold-induced problems first, then the problems caused by snow. In some instances, delineation of the factors is very difficult due to the fluidity of mechanized operations and the synergistic effect mentioned earlier. Consider the following account of a German self-propelled (SP) assault gun in action during the winter of 1941/42:

... the information we received was that we were to bolster up the defensive front at Volkov about 300 kilometers away. Army and divisional reports spoke of the appalling road conditions. In addition to the poor surfaces was added the fact that the weather was terribly bad, with constant snowstorms and freezing temperatures. Quickly we stowed our kit and then came the hardest part of the operation - we had to start the engine. You can imagine the difficulties if I tell you that it was twenty-eight degrees below zero and that our vehicles were in the open although covered with tarpaulins. The method we used to thaw out the engine was to partly fill empty ration tins with earth and to pour on to these either methylated spirit or petrol which we set fire to and put one under the engine and another under the differential. Of course we had to do this under cover of the tarpaulin firstly because the heavy material acted as a windshield and secondly, because we had to hide the light from the little Russian Rata aircraft which flew over us all night long dropping anti-personnel bombs.

....By the time that the engines were running smoothly we had had a hasty breakfast and within an hour of the alarm bell sounding we were on our way through the pitch dark night. Can you imagine what it was like for the driver? The road was rutted and icy and we skidded from one side of the highway to the other. Of course we were driving without any lights, not even the blacked out headlights were allowed for fear of Soviet air attacks and it was a most difficult task to keep in touch with the vehicle in front without crashing into him. Quite frequently one or the other of the heavy machines went into a ditch or ran off the road and had to be brought back again. It was no easy task to reverse on the road; slowly, very slowly, while the crew wrestled to fix the towing cables on the stranded machine. Then both motors would roar as one tried to tow the other out.

For us on the gun platform the journey was a nightmare of freezing cold. The platform was open at the top, the wind howled through the many aperatures and slits in the armor plating, the snow was pouring down and all through the night one man of us had to be standing up helping the driver to keep in contact with the rest of the column. The maximum period of time that any of us could stand up facing into the wind was a quarter of an hour. Quite literally we turned blue in the face from the freezing cold. The whole body

then became an aching mass of pain.... We thought the night would never end.

Although we passed through a large number of villages and towns we made no stop until after first light when we halted for a meal. We had been driving for ten hours. Some of us tied tins of food around the exhaust and heated the. that way. It was quick but if they were left in position too long the tins would nearly explode when they were opened, pouring scalding liquid over hands that were freezing with cold.

We turned off the main road and bumped our way across corduroy roads built by our sappers during the summer across a swamp. It took us a couple of hours driving along those poor roads and through the dark, silent woods until eventually we came out onto the main highway. The pace of the column increased and we covered fifty kilometers quite quickly and then pulled off the road again to halt under the cover of some trees. This was another meal halt and the hot coffee helped to start the circulation going and enabled us to thaw out a little before we moved off again into the gathering darkness. To give the drivers a rest we halted for the night in a village and were billeted in individual houses.

There was no large barn into which the SP's could be parked and thus be under cover and our drivers tried to keep the engines warm by packing them in straw and by covering the engine area with bales of hay. Others had the sentries start the engines every couple of hours. When we set off again the area through which we were passing was said to be full of partisans and we kept our rifles and machine pistols ready for action. Most of us held our weapons inside our buttoned overcoats but one of us had to have his at constant readiness and our turn to stand up in the freezing cold came round as usual every fifteen minutes.

About midday we had a longer break and during this the machines which had fallen out rejoined the column. The workshops detachment had worked wonders repairing the causes of the breakdowns, often with the mechanics lying on their backs in the deep snow tinkering with something underneath the vehicle or struggling with frozen hands to repair the tracks. With the whole group once more assembled we set off across country, up hills and down dales. In the valleys the snow was so thick that we had to shovel a way through it even

though the blizzard which was raging filled in the gaps almost as quickly as we shoveled them clear.

Another night halt in another village and then we spent a day, or the greater part of it, carrying out maintenance on the vehicles and weapons. We were very near our objective now, about eighty kilometers separated us from Volkov, and could expect to go into action within a day or two. We had to be in tip-top condition; all our strength was needed, every machine had to be put in.

In the morning the orders were given: "advance to contact" and we carried out the final parts of our journey in tactical formation and across country moving toward the sound of guns whose fire was brought to us on the incessantly blowing east wind. Our halts were fewer now with just time to eat our haversack rations which we carried inside our coats so that they would not freeze solid.

...By midday we had reached the frozen river on whose far side lay our objective. Slowly the drivers negotiated the steep and icy banks, skidding and sliding down onto the ice which was thick enough to bear the weight of our vehicles. We moved across one at a time so as not to strain the icy surface. Then we climbed the eastern bank of the river, crawling up in a slalom fashion, towing other vehicles where this was necessary. The gun crews broke off branches of trees and put these under the tracks so that they could get a grip on the slippery ice. The engines of our SP's howled like demons with the strain and it was not until after midnight that our battery had grouped in the square of the little village which was our final objective.[2]

Before moving on to cover the cold-induced problems, the issue of man-machine interface needs to be addressed. The purpose of this study is to assess the impact of cold weather upon ACV's. As winters necessarily include snowfall, the impact of snow on ACV's is being assessed also. It is important to understand where the soldier, or crew, fits into this assessment. From a purely technical

standpoint, the soldier is not a component of the weapon itself, but rather he is a part of the overall system in which the vehicle operates. Other pieces of that system include the doctrine which guides employment of the ACV, the technical manuals, the supply and repair parts processes, the ammunition it uses, etc. From an operational standpoint, however, the soldier is an integral part of the weapon system and must be included in any assessment of effectiveness, whether it be a positive or negative impact. This study subscribes to the latter approach. The impact of weather on armored crewmen will be addressed insofar as it affects their ability to effectively man and operate the ACV. In a similar vein, the impact of winter weather upon other system components will be examined with respect to their contribution to the ACV's ability to accomplish its assigned mission.

Cold Induced Problems

Winterization is the process of preparing vehicles, to include ACV's, for operation in cold weather. It includes replacement of the normal fluids and lubricants with those having efficacy in cold weather. It may also include the application of special purpose components or kits to preclude, or at least help to off-set, the deleterious effects of the extreme cold.

Throughout the winter of 1941-42, a significant portion of the German combat power lay in the tank and mechanized/motorized elements of its panzer divisions. On many occasions throughout that winter campaign, the combat power needed by the Germans was not readily available. Thousands of tanks and other vehicles were lost due to inadequate or complete lack of winterization.[3] The Soviets had undertaken winterization of their ACV's to the extent possible within the technical and economic contraints under which they were operating. Basic winterization, such as replacing warm weather oils and lubricants with lighter grade, cold weather fluids, was accomplished.

Few hard facts are available concerning the problems experienced by Soviet ACV's due to the winter conditions. In recounting the problems which arose during that first winter campaign, the overwhelming majority affected the German ACV's. Problems which the Soviets acknowledged and were caused by the cold (or the snow) will be addressed. If on the other hand, an acknowledged German problem was not addressed by any Soviet sources, no reference will be made to it regarding Soviet ACV's.

A major German and Russian ACV sub-systm greatly affected by the cold weather was the powertrain. A tracked vehicle powertrain normally consists of three major component assemblies: the engine, transmission, and final drives, often referred to as the differential. The final

drives, like the differential, are the means whereby the energy output of the transmission is applied to the sprocket, thus causing the track to turn. The German Army powered their ACV's with gasoline engines. The Germans experienced problems throughout the winter in starting engines. There were several causes for this problem. Fuel often froze in the fuel tanks. Additionally, icing occurred in the carburetors and in fuel lines. Many cases were reported of crews being able to get a vehicle started only to have it stall out from icing a few minutes later. Much time was consumed by crews trying to locate the point of icing.[6]

The Red Army had adopted the diesel engine for all of its ACV's designed and produced after 1939. By design, the diesel engine was slightly superior to the gasoline engine in terms of operation in extremely cold temperatures because of its greater reliability. On the other hand, it was theoretically harder to start in cold weather. The Red Army did experience problems in starting engines as evidenced by the many references to solutions for that problem. Even so the Soviets did not appear to consider this problem to be a deficiency of their equipment.

With respect to the fuel system, two points arose which, while not specifically cited in context as the cause(s) of fuel management problems, appear to qualify in this category. The first is that gasoline vaporizes less

readily at temperatures consistently below zero degrees Fahrenheit.[4] This puts an increased load on the carburetor and its parts which are also susceptible to the cold. Additionally, fuel consumption can be expected to increase due to longer and more frequent warm-up periods. The second point is that liquids do not flow well through pipes in cold weather. Even fuel that is warm when it leaves the fuel tank will become more viscous due to conduction of the cold through the walls of the fuel lines. It becomes more difficult to pump the fuel through the lines, placing added burden on the fuel pump(s). It is doubtful the either of these factors were outwardly recognized by crewmen or maintenance personnel.[6] As diesel fuel is more suceptible to the latter point than gasoline, the Soviets may have encountered it, though no mention of fuel problems was found in any Soviet sources reviewed.

Lubricants stiffen in cold weather. Engine crankcase oil would solidify, as would the oil in transmissions and final drives. In some instances, vehicles would start in that condition. Soon however, motor gearings (bearings) would burn out and motors failed due to lack of lubrication.[5] For the Germans, much of the damage of this nature happened early on in the winter, before they realized the full effect of the cold they were experiencing. In desperation, they tried, and often succeeded, in

tow-starting the vehicles. Not only engines, but numerous drivetrains, were destroyed.[6]

Once thawed out, the penetrating cold still adversely impacted the viscosity of lubricants, often overcoming any warming effect from operation In early December, Army Group North was ordered to make a series of attacks to the south of Leningrad to support Group Center's main effort against Moscow. Gen. Erich Heopner's Fourth Panzer Group, now attached to Army Group Center and on its northern flank, started the attack in good fashion. However, the bitter weather conditions prevented them from accomplishing their mission. The attack lost momentum and ground to a halt in daytime temperatures of minus forty degrees Fahrenheit. It was reported that even after extensive operation, the engine oil in the sumps of the tanks had the consistency of tar.[7] To continue would have caused considerably more damage to powertrain components due to the inadequate lubrication.

The problem of frozen powertrain lubricants was not a significant one for the Soviets. The limited winterization accomplished before the start of the winter was the primary reason. The lighter weight, cold-weather lubricants in the Soviet ACV's were effective at temperatures which solidified the summer weight German oils. The Soviets did encounter temperatures, on occasion, that were cold enough to freeze even their cold-weather oils and fluids used in the powertrain components. The problem was exacerbated by

periods of ACV inactivity during periods of extremely cold temperatures.

The lack of adequate antifreeze for vehicle radiators was a major problem for the Germans. Some units such as Guderian's Second Panzer Group, had no antifreeze. Combat readiness was reduced drastically. Other units that had some amounts either did not have enough, or the antifreeze on hand was inadequate for the temperatures being experienced. The German antifreeze, glysantine, was only intended by design specification to provide protection down to minus twenty-five degrees Fahrenheit. Instances were recorded where vehicles would ice up and stall during operation because of a lack of antifreeze. The temperatures got so cold during parts of the winter that where vehicles had no antifreeze, cylinder blocks split open due to the hard freezing.[8]

Again, incidents of radiators freezing on Soviet vehicles were not found even though the diesel engines in use during that period were water cooled and thus susceptible to freezing in extreme cold.[9]

The Germans experienced significant lubrication problems with armament sub-systems. In the extreme cold of the winter of 1941/42, the firing mechanisms of both large and small caliber weapons froze solid. The weapons lubricants used froze at the low temperatures experienced and effectively locked up moving parts. Oil/fluid in the

recoil systems of large caliber guns (tanks, self-propelled artillery, and assault guns) would solidify both in the lines and in the reservoirs, or became so viscous that the recoil mechanisms would not operate. Covering the vehicles with tarpaulins did not help to prevent this situation.

When the very cold weather began in December, numerous malfunctions of weapons, ranging from rifle to heavy gun, occurred because the troops were not acquainted with their proper maintenance in cold weather. Furthermore, the required winter oil was either not available at all, or only in insufficient quantities.[10] This problem was initially severe and widespread. General Halder, Chief of Staff, OKH, observed an armor battle near Tikhvin when the temperature was minus thirty-one degrees Fahrenheit and only one of the five German tanks could fire.[11]

The bitter cold attacked the lead acid batteries of vehicle electrical systems. The cold reduced the electrical output of the batteries substantially. In many cases, even if the engine had been adequately prepared, the batteries could not have provided the power needed to crank the engine due to frozen electrolyte. Extreme cold ruined batteries by causing the metal plates inside the case to warp, or the sides of the case to crack. In order to accept a charge of electricity, batteries had to be warm. To do this meant removing them from the ACV and taking them inside of a shelter. Removing and replacing the batteries was very time

consuming and a physically demanding job since they were located in a hull compartment almost inaccessible to the crewmembers. A final battery problem was inedequate amperage specifications; the cold, coupled with turret operation without the engine running (known as silent watch) for any length of time, generally proved to be more than the batteries could accept and still provide adequate cranking power.[12] The result was a requirement for frequent recharging and a reduced battery life.

In addition to the armament, fire control components of German ACV's were adversely affected. Tank and artillery elevating and traversing mechanisms failed at higher rates than normal in extreme cold. The grease in traversing-gear boxes, like other lubricants, froze solid. The gearing was suceptible to damage if the traversing mechanism was forced. Elevation mechanisms were hydraulic. The fluid in the hydraulic cylinder also froze solid, locking the gun into a fixed elevation until it thawed out.[13] Natural rubber was extremely suceptible to the cold; rubber eyecups on optical sights fell apart/disintegrated in cold weather. Optical gun sights and telescopes frosted both internally and externally. The internal frosting, referred to as "blooming",[14]rendered those instruments useless until a major repair action could be made on them. The external lens frosting was a problem only in that it was a nuisance which scraping resolved in short order.

Metal, to include armor plate, became more brittle and prone to breaking in the extremely cold weather experienced. Large and small caliber weapon springs became so brittle in the low temperatures that they broke as if made of glass.[15] Tempered steel parts cracked and failed.[16] In addition to becoming more brittle, large sheets of armor plating used on ACV's on occasion warped or buckled due to the very low temperatures and constant exposure over a prolonged duration. The buckling of the plate, combined with the increased brittleness at low temperature, reduced the amount of armor protection afforded the crew of the vehicle. Belly armor, by virtue of its greater dimensions, was particularly vulnerable to this anomaly, thus reducing its abiity to withstand anti-tank mines. This effect was common to the ACV's of both forces.

Cold temperature degraded ballistic accuracy of both large caliber direct and indirect fire weapons. The direct fire weapons (tanks, tank and assault guns) experienced significant accuracy problems due to the extreme cold (minus twenty-five degrees Fahrenheit and below). The cold caused the ammunition propellent to burn less rapidly than it did under more moderate temperatures. This slower burning lowered the muzzle velocity of the projectile, thus often causing the round to fall short of its intended aim point. The magnitude of the problem varied with the firing tank to target range and how cold the ammunition propellant was at

the time of firing. The tank fire control system was not designed to compensate for this variable error.

The Soviets acknowledged the existence of this phenomena in post-war accounts of winter warfare. It is important to note that it was addressed not as a problem, but rather as a condition of winter warfare.[17] From such treatment, one may infer that the Soviets considered the effects of certain winter conditions to be inevitable and irreversible.

The whole concept of handling field artillery had to be rethought and new ideas introduced to counter the peculiar effect which temperature had upon the propellant charges, the flight of the projectile and its characteristics. Conventional flash and sound ranging accuracy suffered.[18] Though both forces suffered from the effects of this problem, it was more significant and had a greater impact upon the Germans. At this stage of the war, German field artillery techniques were relatively advanced in application and well integrated into the maneuver elements' operations. The Russian field artillery was less sophisticated and skilled than the Germans at this point, therefore it was difficult for them to specify the extent or impact of the problem.

The effectiveness of German radio equipment was decreased by the cold.[19] Signal equipment lubricants which were not cold-resistant had the same shortcomings as other

lubricants - they became hard and brittle. In general, the electrical qualities of radio apparatus did not change in cold weather, however, water condensation freezing inside radios caused damage. The radio equipment of ACV's could be operated down to minus four degrees Fahrenheit without special measures being taken such as warming the inside of the turret. The Germans found that heavy icing of ACV mounted radio antennas reduced the radio's operating range substantially. Furthermore, antennas were easily broken by crews during de-icing actions.[20]

Another problem area reported by the German Army was that of engine preheaters. German tanks were reported to have had to overcome many technical difficulties, such as having to start with preheaters.[21] That preheaters were a problem is surprising considering the significant difficulties the Germans experienced in starting engines. The problems associated with using the preheaters outweighed the hardships associated with more primitive means of getting the engines warm enough to attempt a start, i.e., building small fires under the oil sump. Preheaters were reported to have caused secondary failures of the electrical system and found not to be durable. The use of preheaters essentially saved the crew no time in getting the vehicle started.[22]

It was found that moisture and grit/dirt inside of ACV's formed a mixture, that when frozen, literally blocked

the operation of the steering, brake, and other mechanisms. The Soviets reported this problem and considered the accumulation of this mixture to be inevitable.[23] By the very nature of their operation, ACV's were prone to a build-up of dirt, water, and foreign material in the hulls and turrets of their vehicles. Mechanical linkages found in the mechanisms affected froze in place when coated by the gritty mixture.

A problem developed during that winter which was peculiar to tank operation alone. The Germans found that their tank turrets often froze in place and could not be traversed (rotated). The cause of this problem was combination of both the snow and low temperatures, however, the cold was the catalyst which intensified the effect. The Germans found the turrets most likely to be frozen when the tanks were shut down during a snowfall, after having been operated for some time. The snow melted upon contact with the relatively warm turret and ran down the outside of the turret wall, collecting in the turret ring area. As the tank hull and turret cooled, the pooled water would freeze solid on the bearing and race surfaces, effectively locking the turret in position.[24]

During the fall muddy season, planking or timbers, and sometimes even trees, were laid across roadways to provide better traction. Roads prepared in this manner were called corduroy roads. This was done primarily to assist

the wheeled combat and supply vehicles to get through the deep mud, but it also proved helpful to ACV's in instances of extremely muddy conditions. These corduroy roads became a problem in the early stages of winter after the hard frost began, but before the heavy snows set in. The planking or the trees, whichever was used, became frozen rigidly in place. The effect was an endless procession of speed bumps, which caused damage to the ACV suspension system if negotiated at too great a speed.

A problem for the Germans caused indirectly by the cold was increased fuel consumption. Overall, fuel consumption for ACV's increased by a factor of from two to four times the quantity used during the summer months. The cold did not account for the total increase; increased consumption due to snow will be discussed in a subsequent section of this chapter. The cold weather caused longer warm-up and engine idling periods. Often, ACV's were idled continuously during periods of extreme cold rather than shutting them down and running the risk of not getting them started later. Some vehicles were left running throughout the night so they could be used to start other unit vehicles the next morning. The tactical situation often prescribed procedures of readiness for action which, due to the cold temperatures, increased fuel consumption. Consider this early winter (November) account from Army Group Center:

> The Russians would attack during the night... and it was necessary that the task group be constantly on the alert defensively. In order to do this it was necessary to maintain the tanks' engines at the right temperature. Every four hours the motors were run for 10-15 minutes until they had reached a temperature of 140° Fahrenheit. These periods commenced for all tanks at exactly the same second in order to minimize interference with the forward listening posts... We discovered that the transmissions must also be operated while the engine is idling, otherwise by a sudden start the metal parts of the powertrain from the engine to the drive sprockets would be damaged (because of the low viscosity of the oil at these temperatures).[25]

The Germans found early on that cold, metal surfaces could not be touched with bare hands, for the skin immediately froze to such surfaces. Not only were ACV crewmen susceptible that type of injury, but also foot soldiers using the tank for transport. That the Germans included instructions in their 1942 winter handbook was evidence that they considered the problem significant.[26] The Red Army acknowledged the problem, but were more dramatic in addressing it: "There were heavy frosts, and steel literally burnt at every touch, but the men never left their tanks, mounting one counter-attack [sic] after another."[27]

Tanks, assault guns, and armored personnel carriers generally have to bear the brunt of mobile combat in the winter.[28] A necessary corollary to that is that the crews who operate those systems will also have to bear the brunt of the effects of the harsh conditions.

For German ACV crews, the short-lived fall muddy period was the start of a bad time. The continual rains brought about almost constant confinement to the inside of the tank, which was cold and cramped. Combat efficiency began to drop at that point.[29] It was in December, just as the German offensive reached its culmination in front of Moscow, that the dreadful conditions began to impact upon the crews of the ACV's. Numerous cases of freezing-to-death occurred. Tank crews tried to warm the inside of the tanks with charcoal fires. Through ingnorance and carelessness, carbon monoxide poisoning resulted. Other than that, so much condensation formed that with the rapid cooling off from the outside, the optical instruments and the weapons became covered with ice.[30] Adequate cold weather clothing for ACV crewmen was not available. Crewmembers had to wear the issue woolen overcoat, which was a great burden. The confines inside the tank were small and the bulky coats severely limited movement.[31] A design feature of several of the tank types further compounded the crew's misery in that air for the engine was drawn in from the outside through the fighting compartment. The cold draft of air which resulted was considered to have had an adverse effect upon crewmember health.[32]

The bitter cold temperatures (minus twenty-five degrees Fahrenheit and colder) permeated the iron mass of an ACV and turned it into an icebox. There was little room for

movement inside the turrut or driver's compartment, yet to sit still was to freeze to death.[33] The foot soldier's greatest fear was having to leave his shelter for posting to a security outpost or as a guard sentinal.[34] The tank crewman's dread was having to stand watch in his vehicle.

Of all winter's elements, the cold caused the most problems and gravest concern with respect to the ACV man-machine interface. The effect of the unceasing cold was a continuous requirement upon the crew to take some action to either prevent, correct, or compensate for the cold, i.e., frequent periodic starting, careful armament de-icing, etc. Frequently, expedient solutions devised to correct one problem resulted in creating another. The cold was the ultimate challenge, for of the winter's conditions, it was the only direct killer.

Snow - induced Problems

By far, the major impact of snow was upon mobility of both combat and logistics' support vehicles. The greatest impact was on wheeled vehicles; ACV's fared somewhat better, particularly those of the Red Army. The two ingredients which largely determined mobility through snow were its depth and texture, i.e., heavy and wet or powdery and light. According to an account by General Gustav Hoehne, the winter of 1941/42 was notorious for both its depth and powdery texture:

> Western Europeans will be hard put, to imagine the masses of powdered snow that, during the most severe part of the winter 1941-42 buried western Russia beneath a blanket averaging 1.2 meters in depth. Not every Russian winter is marked by that much snow, nor does the snow always remain so powdery. During the subsequent winter of the war, for example, things looked differently. Heavy snows were common, to be sure, but never again did they assume those proportions, and a few warm days were enough to deprive the fresh snow of its powdery texture.[35]

The mobility factor of a tracked vehicle is often expressed in nominal ground pressure; the lower the pressure, the better the vehicles performance over soft ground. This pressure is the ratio between the area of track in contact with the ground surface and the weight of the vehicles.[36] Lower ground pressures could be achieved by increasing the area of track in contact with the ground surface, e.g., lengthening the track or making it wider.

Another design consideration with respect to ACV mobility in snow is ground clearance. Ground clearance is the distance from the ground surface (under the tracks) to the hull bottom's lowest point. The greater that distance, the less suceptible the vehicle is to becoming high centered,or in the jargon of the tank troops, "bottomed-out."[37]

The snow mobility of German ACV's was limited because of their relatively narrow track width and low ground clearance. These factors combined to severely restrict the cross-country capability of German ACV's. The depth of snow required to obviate ACV off-road movement was dependent upon

several factors. The different types of snow, dry and powdery vice wet and heavy, had different effects upon mobility of ACV's. On the whole, dry snow presented fewer problems because it was light and less prone to packing thus less likely to cause bottoming-out. Terrain relief was an important consideration also. Greater snow depths were negotiable over relatively flat land or downhill grades than up even moderate grades.

Because of the variables, it was difficult for the Germans set precise rules concerning the maximum snow depths for ACV mobility. According to the handbook published prior to the second winter campaign, the maximum depth of snow for tanks to negotiate, on level ground, was twenty-two inches.[38] There was no discrimination made between wet or dry snow. Other accounts purport a significant difference in capabilities of ACV's based on the snow texture. Dry snow could be effectively negotiated up to the eye level of the driver, as seated in his compartment. On the other hand, wet snow was found to preclude mobility at depths greater than twenty-one inches.[39] Additionally, it should be noted that short thaws, at least one of which was experienced just before Christmas in 1941, severely degraded ACV mobility by changing a firm, dry snow into a wet, spongy surface, conducive to bottoming-out. Drifting snow, which was more prevalent with dry, powdery snow, acted to compound and complicate the problem of mobility in snow. Without

exception, snowdrifts were not capable of being traversed by ACV's without some kind of prior conditioning or preparation.

The Red Army did not experience problems with ACV mobility in snow to the extent the Germans did. They enjoyed relatively good cross-country mobility due to the wider tracks and higher ground clearance of their ACV's, which predominately consisted of tanks at this stage of the war. As with the German experience, it is very difficult to determine at what depth of snow the Soviet ACV became immobilized. One source reported that snow more than twenty-four inches deep would effectively stop all ACV movement because they would bottom-out; a snow depth of from sixteen to twenty inches reduced the speed of the tracked vehicles to about six miles per hour. These figures are based on experience, without specially prepared kits or additions to the vehicles. A point of comparison was the effect on wheeled vehicles: normal speeds were possible with depths up to four inches; reduced speeds up to twelve inches; and no movement at depths above twelve inches.[40]

It suffices to say that the mobility of the Soviet armor in snow was extraordinary. German accounts of small unit actions time and again marvel at the Soviet tanks' ability to maneuver through snow which completely stopped the German tanks. The major problem experienced by the Soviets, with respect to mobility in snow, was drifting.

They also could not negotiate the snowdrifts which accumulated on a massive scale in the Russian countryside.

The phenomena of solidly frozen marshes thawing under the warming effect of a heavy snow layer was a significant problem to the German forces in the north and central sectors. Sub-freezing temperatures occurred during the German advance on Moscow and the advances in the north to reinforce the hold on Leningrad. The consistently cold temperatures continued to harden the freeze on the marshes and swamps to the point that passage by track vehicles was supported. The German offensive bogged down at about the same time as the heavy early December snows began; the Soviet counteroffensive was in full operation by mid-December when the bitterly cold temperatures hit the front. The Germans often had to withdraw back across areas they had traversed previously when those areas were frozen solid. The German forces were unaware of the warming effect of heavy snow on the under-lying ice and, as a result, lost considerable equipment.[41]

During the German advance forward in October, November, and early December, the Red Army destroyed the bridges they crossed as they withdrew. As a result, alternate semi-permanent and permanent bridges were built by German engineers. They used the original locations when possible, but often built completely new bridges to the flanks of existing sites. Frequently, in order to reduce

the width of the span, the replacement bridge was built closer to the water, i.e., farther down the banks. That caused no problem in summer, however, in winter the steep ingress and egress slopes were slick due to snow and ice and caused increased difficulty for ACV's.[42]

The Russians, except for local occurrences, did not face this problem. During their withdrawal, they used the existing bridges, then destroyed them after crossing. Even though limited territory was recovered during their counteroffensive, several bridges, erected by the Germans, were found intact and used. When no bridges were available, river crossings were made over the ice which had been cleared of snow (at selected sites) and frozen hard enough to support heavy ACV's.

Snow goggles were needed for extensive operations in snow-covered terrain. The goggles were required for protection against snow glare in clear weather and to help crew members see during movement in falling or blowing snowfall. The former situation favored tinted or smoked lens while the latter found clear lens better, particularly at night. On occasion, however, not even goggles helped:

> At six the next morning, the same reconnaisance tank set out on another mission. The weather was very bad, and visibility almost nil. At twenty meters nothing could be distinguished. The snow, swept into the tank by the cold wind, covered all the instruments with a thick layer, and every 50 meters the driver had to stop and again grope his way forward.[43]

Supplying goggles in adequate quantities for the ACV crewmen was seldom possible due to higher priority supply items as ammunition and fuel.

Another problem caused by the snow and placed in the mobility category was a significant (two to four times higher than German summer rates) increase in fuel consumption. The deep snow caused engines to have to work harder in overcoming the greater resistance of the built-up snow mass. Travel was slower and ACV's were kept in lower gears in order to prevent stalling out. These measures sacrificed any efforts aimed at fuel economy. Additionally, ACV's were often given special missions, such as road maintenance or vehicle recovery operations. Those types of missions consumed vital fuel stocks and stressed the vehicles beyond their design limits, all the while detracting from essential combat tasks.

A problem peculiar to snow and somewhat related to mobility was presented by travel through heavily wooded sections. While moving through woods and forest, ACV's were handicapped by the snow that constantly fell off the branches onto the periscopes and portholes and completely obscured the field of view. This made it necessary to stop the vehicles frequently to let the crews get out and clear off the snow. In the dead of winter, when a thick layer of snow covered every branch, the vehicles sometimes had to stop every five to ten minutes.44

It is important to understand that the mobility problems caused by snow were felt across the entire theater of operations, save the Black Sea and Crimea area. In mid-December 1941, the Third Panzer Division, Army Group South, was ordered to move east and participate in a German offensive to secure needed oil fields in the Caucasus region. The first day of the march was scheduled to be 16 December, however, traffic control parties sent out the day before reported parts of the nearly one hundred and fifty mile route impassable due to heavy snows. As a result, the division's march date was delayed to 17 December and an engineer battalion, two recovery platoons,and three signal detachments were sent out to open the road, via engineer work or stranded vehicle recovery, and to establish and maintain communications. Much of the road was cleared by the night of 16 December. Drifting snow, however, caused large segments to be impassable by the morning of 17 December.[45]

Snow in the muzzles of the weapons caused the barrels to burst when they were fired. Special care had to be taken to ensure that ice and snow were removed from the muzzles before firing. The firing of high-explosive ammunition through an iced muzzle resulted in the round exploding in the tube, damaging it beyond repair.[46]

Snow had a degrading effect upon the observation of assault gun and tank direct fire for both forces, but more

so the Germans due to unfamiliarity. When these weapon systems fired, the muzzle blast caused large swirling masses of snow in front of the tank, obscuring the gun crew's view of the target. This problem was more pronounced when the snow was dry and powdery, or when the weapons were fired from unprepared positions. Because the snow completely obscured observation of the target, if the target was not hit, it was extremely difficult for the crew to tell where the round hit in relation to the point of aim so an adjustment could be made prior to launching a subsequent round. The Red Army experience and familiarity with large caliber direct fire in deep snow appeared to have precluded problems in this area. Nothing was found indicating the Red Army experienced problems of the kind described.

The indirect fire of the field artillery experienced similiar type problems. The deep snow not only reduced the force of the explosions of light shells, but also concealed the fall of the shot from artillery forward observers or spotters in light aircraft.[47] It was also very difficult for artillery forward observers to determine map/locations; the uniform blanket of snow effectively masked, or at best made difficult, the recognition of man-made and natural terrain features normally used for that purpose. The Germans were more affected by problems in this area than were the Russians. Indirect fire support was a significant contributor to their overall combat power. In many cases,

it provided the combat multiplier needed to effect the decisive maneuver. Additionally, the Germans did not have available the vast quantity of field artillery that the Soviets did, and thus had to optimize the effectiveness of what they had.

Use of the snow in the construction of defenses, i.e. its preparation, also was a cause of problems to the attacker, which both the Germans and Russians were at some point during that winter. Iced snow walls with long slopes proved to be effective obstacles against ACV's. The vehicle's tracks would slip on the iced incline causing a complete loss of traction. Care was taken to ensure the ice walls/slopes were emplaced in locat ons which prevented the ACV from backing off far enough to gain adequate momentum, when it came forward again, to negotiate the slope.

The effects of large caliber direct and indirect fire weapons was reduced by defensive earthworks made of snow and sand. Defenders would build parapets, seven to ten feet in width, of mixed snow and sand, over which water was poured. The result was called "snow cement" and it proved relatively effective in stopping large caliber projectiles.[48]

Another problem associated with snow caused problems for defenders of prepared positions. It was found that obstacles, antitank or anti-personnel, placed in front of defensive positions often caused the snow to pile up around them. This situation blocked the line of sight of the

defending weapon system. The impact was significant on tank and assault gun positions, as it generally required those ACV's to relocate to new positions. For the German vehicles, which had limited snow mobility, this was no easy chore.

The changing conditions attributable to a Russian winter, though common place to the Russians, were a source of frustration for the Germans. For example, changes in weather, or even in the wind direction, significantly altered the results of a reconnaissance completed before the change. Until experience taught them otherwise, the Germans conducted large-unit road marches based on route reconnaissance information that later often proved erroneous due to a change in weather subsequent to the reconnaissance. Changed wind direction and its influence upon snow drifting was a good example of this problem.

A problem related to changing conditions had to do with ACV camouflage. Early in the winter season, the Germans found that the whitewash or paint applied to the ACV might be inappropriate a few kilometers or hours later. On into the season, after the heavy snowfall came, the problem was eased considerably, however, re-camouflaging was required when moving from open terrain into forested areas or vice versa.[49]

The following chapter will address the solutions to the problems described here. Additionally, the impacts of

the problems will be discussed as they influenced tactical, operational, and strategic plans and actions.

ENDNOTES

CHAPTER IV: THE EFFECTS OF WINTER WEATHER ON ARMORED UNITS, 1941 - 1942

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9. It should be noted that somewhat of a dilemma exists regarding how to interpret a lack of information on a topic. In contrast to normally comprehensive German coverage of problems experienced, very little has been divulged in the post war years concerning specific Soviet problems attributable to the winter weather conditions. That the winterization process included the addition of antifreeze to AFV radators is a certainty; that the antifreeze was effective at the extremely low temperatures is not certain, nor is it uncertain. Russian experience and experimentation prior to the war may have been adequate in determining both solution composition and strength to withstand the temperatures experienced.

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CHAPTER V

SOLUTIONS TO THE PROBLEMS ENCOUNTERED AND THEIR IMPACT UPON OPERATIONS

> The time for spectacular operational feats is past. Troops cannot be shuffled around anymore. The only course lies in purposeful exploitation of tactical opportunities.
>
> Colonel General Franz Halder
> Chief of Staff
> German Army
> 11 November 1941

Before addressing specific solutions to and impacts of the problems caused by the weather of the first winter campaign, it is necessary to review briefly the operational perspective of each of the belligerents. For the Germans, the winter of 1941/42 was the first time their armies had been checked and, in some areas, thrown back. German plans were set in motion to launch summer offensives to recover the lost ground. Additionally, efforts were intensified to prepare for a second winter campaign on the premise that the Russians would not be defeated during the 1942 summer campaign.

The Soviets, on the other hand, were buoyed by their successes during the winter campaign. Although Leningrad in the north was still under seige, German advances in the south had been checked. In the center part of the front, German advances on Moscow had been blunted and lost territory retaken in several sectors west of Moscow. By the

end of the winter, the Russian capital was safe from the threats of German capture. The turning point of the war had been reached.

The end of the winter campaign did not mean an end to the German challenges however. The German Army faced a tremendous task immediately after the 1941/42 winter campaign, not only in identifying the multitude of problems they encountered, but in developing solutions acceptable to field units, and then publishing and distributing the same. The problems experienced by ACV's due to winter weather were only part of a far greater number which afflicted the German forces overall. Mechanized combat under the conditions experienced was never envisioned by German ACV designers because winter conditions that harsh were not experienced in Western Europe. The Germans had rapidly developed an ability to improvise; expedient solutions had become the norm.

The Germans essentially used a dual-track process in solving their problems. All problems which arose with ACV's due to weather impacts and causing a loss or degradation of mission capability were reported through command channels up to OKH and OKW. It appeared the first problem analyses occurred at the General Staff level. Here, problems were generally categorized as deficiencies for which the vehicle design could be modified quickly to correct, or for which the only fix was long term with respect to effectivity or

date of implementation. Problems falling into the former category were tasked to the Ministry of Armaments for corrective action on an expedited basis. The Ministry developed the necessary hardware, lubricants, modifications, etc. required for the solution. They were responsible to ensure that it got back to the field units for application as soon as possible. The General Staff addressed the problems for which timely design/technical solutions were not possible. Using liaison visits to the line units, the General Staff drew on the experience of those units to document field expedient solutions. It was a very pragmatic approach - if it worked, and nothing better was available in the short term, it was used.

In preparation for the inevitable second winter campaign, the German Army compiled a winter warfare handbook. It was distributed in August, 1942. The handbook was a primer on how to retain combat effectiviness during a Russian winter. Changes to vehicles or weapon design, or maintenance procedures that were to be in the field by the winter of 1942 were addressed; field expedient or improvised solutions to many winter problems were provided as official measures (until long-term solutions were developed). The German corrective action system was entirely reactive in nature. They, justifiably so, did not anticipate the number and severity of the problems they encountered. Once decisively engaged, they dedicated a considerable effort to

ensure the problems were resolved for future winter campaigns.

The Soviets, fighting in their homeland, knew what to expect. Their ACV's were designed for optimal performance in cold weather operations. They were acclimated and accustomed to the harsh winter weather. Where problems arose for the Red Army ACV's due to the weather, solutions were improvised on the spot, or not solved at all. When the conditions were such that Soviet ACV's were hindered or prevented in accomplishing their missions, the weather was bad enough to completely halt all movement across the front. The Soviet system was largely preventive in nature in that it recognized the characteristics of the Russian winter and reduced or eliminated those effects through the design of the ACV's. For years before the war a great deal of experimental work and hard training were done by the Soviet Army in order to adapt the machines and personnel to the rigorous conditions of the Russian winter.[1]

Solutions to Problems Encountered

Solutions to Cold induced Problems

The Germans adopted field expedient measures during this campaign to keep engines and powertrain components from freezing. The carburetor and fuel line icing problems reported by the Germans were solved on an expedient basis by

muffling the fuel lines, i.e., wrapping them with cloth, from the fuel tanks to the carburetor, wherever accessible. Incidents of fuel icing, particularly gasoline, were a function of water content in the fuel and extreme cold; measures taken by ACV crews and maintenance personnel were directed at the effect, not the cause. No reports were found of any German acknowledgement of fuel contamination or any Quartermaster Department efforts to reduce the water content.

As diesel fuel is more viscous than gasoline, the Red Army may have experienced fuel flow problems, both into (refuel) and within the ACV. However, the Russians reported no particular problems in this respect, although mention was made that vehicles must be started and run at frequent intervals. Ostensibly, the reason was to keep the engine and the oils warm although fuel warming may have been a related reason.

With the onset of very cold temperatures in late November and early December, the Quartermaster Department of the German Army was deluged with demands for lubricants for vehicle powertrains and weapons. The powertrain lubricants available were found to be inadequate in the cold. Lubricants with cold weather properties were not available because up until this time, there had been no reason to develop them. The Quartermaster Department could not provide cold-weather lubricants and oils for its army that

first winter. Adequate lubricants were developed and fielded prior to subsequent winter campaigns. Expedients and improvisation were the norm.

The practice most widely adopted to keep engines warm enough to start was that of building small fires under the engine block and/or engine oil sump. This warmed up the oil and engine enough to permit starting and idling. After idling for specified periods (ten-fifteen minutes), the transmissions would be engaged to ensure it and the final drives were warm enough to operate without damage if ordered to move out quickly.[2] When oil had to be added to crankcases or transmissions, it was heated up indoors in order to melt it so that it could be poured.[3]

Another procedure was used in conjunction with the small warming fires. It consisted of building snow and canvas walls to act as a windbreak. This improvisation was most effective when the walls were constructed adjacent to and on the downwind side of a slope. This technique was mandatory when the vehicles were parked in the open with no shelter.[4]

Lastly, another excellent source of lubricants with considerable cold weather qualities was that garnered from captured Russian ACV's or supplies. These fluids were effective because the Russians had realized that special requirements existed in order to keep vehicles operating in cold weather. As such, special lubricants had been

developed by Russian scientists which were effective at low temperature. Their efforts were aided by the fact that the oil produced from the southern Russian oilfields contained very few impurities and was thus effective at temperatures considerably lower than oil produced from the sources available to the Germans.[5] The high quality crude oil aside, this was an excellent example of familiarity with winter's effects accruing as a military advantage for the Red Army. The winter training conducted prior to the war and the experiences of the Russo-Finnish conflict were adequate to identify problem areas peculiar to mechanized vehicle operation. Where feasible, solutions were developed so as not to impede or obstruct normal operations. When that was not possible, special procedures were developed to permit continued operations in spite of the weather conditions.

The Red Army fared much better with respect to the extremely cold temperatures, but they did have the same problems when temperatures plummeted to minus twenty-five degrees Fahrenheit or colder. They also found it impossible to allow vehicles to stop without starting and running them at frequent intervals. At night or when not in use, the Red Army solved the problem by simply lighting fires under the vehicle. Small fires were lit under each key powertrain component or reservoir, i.e., the engine oil sump/crankcase, transmission, etc.

Different procedures were used by the Russians depending on the length of time the vehicles were going to be out of action. When the situation was such that no movement was planned for five days or more, the ACV's, primarily tanks and, were buried into the ground approximately up to the base of the turret. Trenches were dug between the tracks, four to five feet deep. A portable iron stove was placed under the motor housing, or if not available, a brick stove/oven was built. The fire in the stove was kept going constantly. Engine idling was unnecessary. With such an external heat source, it was adequate just to start the engine three or four times daily to ensure an easy start when needed. It also saved a large amount of fuel and provided a warm shelter for the crews. To maintain security, the turrets and exposed parts of the hulls were covered with tarpaulins and then camouflaged with snow.[6]

On the contrary, if the situation was such that the unit could move at any time, the procedure described was not flexible. A more expedient technique was used. Tarpaulins were used, but the tank hulls were not dug in. Portable stoves were placed near the engine, and the crew could stay under the tarp near the stove to stay warm. Care was taken not to cover up the exhaust, creating a carbon monoxide poisoning danger for the crew. The same measures were taken to provide camouflage from air observation.[7] It is

interesting to note that the Soviets did not consider such measures important or significant, but rather as a necessity for winter combat.[8]

Different solutions were developed to solve the antifreeze problem. Many units initially tried building small fires under the vehicle's radiator. With armored vehicles, the armor plating rendered that technique relatively inefficient. Other units kept on standby a number of vehicles whose engines were started at short, specified intervals. When required, the hot water or antifreeze from the running engines was pumped into the radiator of another vehicle, and the process continued in a like fashion. Units became so proficient at this technique that the hot solution could be passed from vehicle to vehicle so quickly that within an hour a regiment could be ready to move.[9] A slight modification of that procedure was to drain the radiators and then take the coolant inside the troop quarters to be kept warm. The next morning it would be put back into the radiator after the engine and drivetrain had been warmed by small fires.[10] When no antifreeze was available, some units reported using pure alcohol as a coolant. There were two drawbacks to that solution, however. The first was that the coolant was volatile, especially under pressure; the second was that the alcohol attacked and damaged the rubber radiator hoses.[11]

Except for intermittant shortages in localized areas, antifreeze was available within the German supply system during that first winter campaign. The antifreeze was known as glysantine. The best protection that could be achieved was about minus thirty degrees Fahrenheit.[12] According to Generalmajor Oskar Munzel, minus forty degrees Fahrenheit could be achieved with a three-part glysantine, two-part water concentration. In all cases, the coolant had to be checked frequently to ensure the protection had not eroded.[13]

The Red Army acknowledged the problem of freezing radiator coolant. They also did not have antifreeze which was effective at the temperatures experienced. The Soviets found that at temperatures below minus forty degrees Fahrenheit, antifreeze was of relatively small value. Much like the Germans (who may have copied from the Russians), engines were kept running as much as possible. When it was necessary to stop for a long period of time, the coolant was drained from the radiator. Before starting the engine again, it was necessary to first flush the radiator with hot water or coolant, then fill it with a hot water/antifreeze solution.[14]

Armored combat vehicles that could not fire their main armament because of frozen recoil fluids and gun lubricants created serious problems. The German solutions consisted of both expedients and procedural techniques. The

overall German superiority in combat power was substantially degraded during the periods of extreme cold which occurred before corrective procedures were effectively applied.

When weapon breech blocks, operating mechanisms, and recoil fluid first started freezing, experiments were conducted at small unit level to find or improvise a solution. One of the first measures taken was to fabricate small field stoves to put under the breech mechanism and near the recoil fluid reservoir (the replenisher).[15] These stoves kept all operating parts and fluids warm enough to fire. Problems with this technique were soon found in two areas. First, small stoves in the turret produced carbon monoxide which would incapacitate or kill crewmembers. Secondly, the weapons began to sweat when heated. Unless the moisture was wiped off thoroughly, when the heat source was removed, the weapon froze solidly. Also, when the weapon stayed warm for a considerable time, it was subject to rusting.[16] This solution caused more problems than it solved.

The ACV crewmen, as well as crew-served weapons' crews, continued to experiment. They soon determined that kerosene was cold resistant and suitable as a lubricant. A drawback was that it did not last long and had to be reapplied frequently. The weapons functioned using kerosene as a lubricant, but its effect in causing excessive metal corrosion was unknown.[17] Some units adopted the practice of

removing all lubrication and operating the weapon completely dry.[18] Sunflower oil was used a field expedient weapons' lubricant by many of Army Group South's units. It proved to be an excellent cold weather lubricant. The oil was nearly acid free. To the German's dismay, it was found in limited quantities and then only in southern Russia.[19] Finely ground powders were used by some units to keep breech assemblies operating.[20] Lastly, an excellent improvised source of lubricants with the cold-resistant qualities needed was that available from captured, intact Russian equipment.[21]

The German Winter Warfare handbook was very helpful in preparing forces for the second winter campaign and addressed armament care and lubrication in considerable detail. Improved weapon lubricants were provided for subsequent winter campaigns, however, there were still limits as to their effectiveness. Certain types of cleaning and lubricating oils required kerosene be added to them as a thinner once designated temperatures were reached, i.e., gun cleaning oil: minus twenty-two degrees Fahrenheit; lubricating oil: minus four degrees Fahrenheit.[22] The frost-resistant oils which were developed and issued to the units in the north and east were usable down to minus forty degrees Fahrenheit. At lower temperatures, even these oils had to be mixed with kerosene. Recoil fluids for large caliber weapons were developed and rated as effective down to minus seventy-six degrees Fahrenheit.[23]

Special instructions were provided concerning tank and artillery armament and munitions. Recoil brakes had to be filled to the proper level and breech operation had to be checked often.[24] The manual provided detailed instructions for care and maintenance of the tank's machineguns during cold weather operations. The storage and handling of munitions in winter conditions were addressed also. Ammunition was covered to protect it from absorbing moisture. Before being loaded, shells had to be cleared of all ice and snow, otherwise, they would jam in the chamber.[25]

Lead-acid storage batteries were also susceptible to damage from the cold of the Russian winter. In order to keep them from freezing, batteries were often removed from vehicles and stored in troop shelters overnight or during periods of inactivity. At other times, they were removed and individually wrapped, then put into straw-lined boxes left outside in a wind-shielded location.[26] The German crews found that if the batteries were well-charged and maintained that way, they were much less likely to freeze.[27]

The Germans found that not much could be done for cold-induced fire control problems other than field expedient solutions. Fires inside ACV turrets were prohibited both from a safety standpoint and to prevent condensation from forming and subsequently freezing on components.[28] Frozen components, such as elevating and

traversing gears, had to be thawed gradually, often with great care. According to the handbook, some gearing was factory-produced with a grease which retained good lubricating properties down to minus forty degrees Fahrenheit.[29]

The glass portions and eyepieces of optical instruments were coated externally with a very thin layer of a light grease, such as petroleum jelly, to prevent frosting or blooming. In some units, optics were coated with glycerine to keep them operable.[30] One expedient solution devised to prevent frosting which proved effective was to rub the optics with common salt several times daily.[31] Another solution to reduce or obviate the impact of the cold was to remove the most vulnerable components and place them in a wooden container lined with straw and blankets. This procedure was not practical for front line units.

There was no real solution to increased metal brittleness experienced at extremely cold temperatures. ACV crewman learned quickly that many machined parts became very brittle when subjected to extreme cold and could not withstand any stress at those temperatures. Springs were especially susceptible to breaking. Awareness of the problem on the part of the ACV crews was the best solution. Additionally, the German Winter Warfare handbook emphasized deliberate and careful handling of these types of parts and warned against forcing or overstressing frozen components.[32]

The problem of degradation of both direct and indirect fire ballistic accuracy due to the cold was not resolved. There are no indications that the Germans undertook any efforts to quantify the problem or to develop a feasible corrective action. Such a position (non-action) was congruent with a perception of the problem as being an inevitability of winter warfare.

The Red Army, on the other hand, developed modified firing tables for the field artillery to compensate for ballistic changes due to the cold.[33] That they developed new firing tables was surprising because the Soviet field artillery doctrine of that time emphasized quantity vice quality of fire. The Soviets did not address the direct fire accuracy degradation problem.

The radio equipment of German ACV's could, in general, be operated at temperatures down to minus four degrees Fahrenheit.[34] Operation at temperatures lower than that required special procedures. Vehicular operation was normally adequate to keep the interiors warm enough for the radio to work. When vehicles were stopped for more than a few hours, radios were often removed and placed in containers lined with straw, or wrapped in blankets, and put in a location shielded from the wind. They could not be taken into heated shelters for they would sweat inside the cases, then freeze and malfunction upon reinstallation.[35]

The Soviets did not experience this problem for they had no radios in their ACV's.

The use of engine preheaters by the German forces was discarded during this campaign. The preheaters were not reliable and the German forces could not accept that level of uncertainty.[36] Furthermore, the complicated preheater system took considerably more time to warm engines than did the small fires built underneath.[37]

Turrets locked in place by frozen turret race rings were avoided by ACV crewmen judiciously clearing the turret of as much snow as possible. Then, before the vehicle was put away, a tarpaulin was used to cover the turret to protect it from the immediate snowfall melting and freezing in the ring. Much the same technique was used on the open-topped assault gun, however, the goal with it was to keep snow off the fire control and the turret components.[38]

The problem presented to the ACV's by the frozen corduroy roads was solved by the winter itself. These roads, so useful in the muddy season, became snow-covered to a depth which greatly exceeded that of the logs or planking used in the roadbed. As the snow cover was continuous throughout the winter until the spring muddy season, corduroy roads were not a significant problem.

The problem of the increased rate of fuel consumption due to cold temperatures was not addressed by the German Army as a specific problem which had to be solved. A more

pressing problem for the Germans was ensuring the vehicles would start and could be operated in a short time without causing damage to the powertrain. Although the use of small warming fires was considered the most efficient solution, the exigencies of the tactical situation were understood. Line commanders had the authority to employ whatever measures they deemed necessary to accomplish their assigned missions. Thus, for the Germans, the high rate of fuel consumption became more a problem of supply capability for the logisticians.

The Red Army approached the problem somewhat differently. Their solution was to prescribe specific norms to be followed in keeping vehicle powertrains from freezing, while not idling the ACV's excessively. The norms developed, as described earlier in this section, were directive in nature upon the tank and mechanized units.[39] By that action, the burden of reducing fuel consumption was placed almost entirely on the combat units.

Bare metal surfaces had to be warmed before they could be touched by mechanic's or crewmember's hands. German ACV crewman had to take extra care to ensure unprotected skin did not come into contact with cold metal. ACV commanders were warned about letting bare metal surfaces of radio headsets touch the edges of their ears; they were advised to wear the issued knitted woolen cap under the headset. The same warning was given for the metal helmet.[40]

There were no adequate solutions to relieve the sufferings of the German crews during this first winter. The first German tank to have a vehicular heater was almost two years away. In order to avoid freezing to death, the tank crews tried to remedy the situation with all available resources. They became quite resourceful. The floors of the turrets of the ACV's were often covered with straw mats. Cloth sacks were filled with hay and straw, and the crewmen kept their feet in them to prevent frostbite while in the tank.[41] To protect their faces, cloth masks were fabricated and warmer fur masks were requisitioned. Crumpled newspaper proved itself to be a superior antidote for the cold when used as insulation under the regular uniform garments.

During an assignment as a security outpost, which often lasted for days and nights, crewmen dared not sit still in the vehicles, but had to constantly keep moving. The reliefs in the tanks were so organized that two crewmembers stood watch, and, after about thirty minutes, wakened the other crewmen to take over. They then performed several minutes of calisthenics to warm themselves. Only in this manner could they prevent their hands and feet from freezing.[42]

German ACV crewmen were not equipped with adequate clothing. Electrically heated combat suits were experimented with. The suits were not successful because the supply of electric current in the tank's batteries was

too weak to make the suits effective.[43] Proper clothing, such as warm combat suits, were not available, except when captured from the Russians. The needed warm clothing was provided in time for the second winter campaign.

Red Army ACV crewmen faced the same elements, but suffered less because they were better prepared for the winter. Soviet ACV crewmen were provided furlined combat suits, furlined caps, and felt boots. Extensive tests and experimentation before the war resulted in clothing and equipment adequate to keep ACV crews and their weapons functioning, though at times with limitations, throughout the campaign. The Soviets also found that operating and maintaining ACV's were more difficult in the winter conditions. As a result, during the planning of operations they allocated more time for maintenance. This eased substantially the strain on crews and maintenance elements.[44]

Solutions to Snow-induced Problems

The German Army was unable to improvise or develop an effective solution to the problems they faced in ACV snow mobility during this first winter campaign. As a result, the focus of the German effort was on sustaining the limited mobility that was possible. It was not possible to develop significant vehicle design changes and implement them during the same winter. The onus of making the best of a bad

situation fell upon the using units. The Red Army did not share this problem. Only in very deep or drifting snow was Soviet ACV mobiity degraded. The wide tracks and high ground clearance were features designed purposely to provide mobility in the snow and mud of the magnitude found in Russia.

As cross-country mobility was almost out of the question, German ACV's were largely limited to roads. Existing roads which were to be used were kept open by plowing or compacting the snow.[45] When available in adequate numbers, ACV's were often used for these road maintenance missions. Where no roads existed, or when the use of existing roads did not support the scheme of maneuver, new roads were often made by compacting the snow over the designated route. Quite often, units of local Russian peasants were formed with the mission of road maintenance. In most cases, it was only possible to fabricate a one lane road supporting traffic in one direction. Traffic control procedures were very important. If time and resources were available, bypasses were built to accomodate traffic in the opposite direction. In order to keep march columns moving, a tracked recovery or towing vehicle was placed at the front and rear of each column. The vehicle in the front of the march column cleared the route of disabled vehicles left behind by the preceeding

march unit, while the rear vehicle recovered elements of its own march unit.[46]

When the supply situation would permit, worn tracks were replaced in order to increase their grip under icy conditions. Every tank was required to have some spare track blocks which could be thrown one by one at intervals under the tracks. Often, that was the only means of negotiating steep ice or snow-covered slopes.[47] When off the roads, ACV crews were instructed to avoid all ravines and steep parts of the terrain in order to avoid getting stuck. When high-centered in snow, the best solution was to back out and find another route. The German mechanized forces soon learned that ridges and hilltops supported mobility more than other areas because the wind would blow the powdery snow off those high locations down into the lower areas, i.e., drifting.[48]

Off-road movement often involved the whole crew in trying to observe forward to provide early warning of obstacles. Vehicle commanders had to assist drivers more than usual. Since they were located higher in the vehicle, they had a better view of the immediate terrain. Whenever there was a doubt if the vehicle could make it through the snow, a crewmember was normally dismounted for a foot reconnaisance.

For a short while, some German panzer units had a few "snow grousers" available. The snow grouser was a bolt-on

modification to the existing track block. It was basically a steel cleat, as wide as the track and of sufficient height to enable it to dig into packed snow and ice for traction. Unfortunately for the Germans, most of the grousers were sheared off and lost after just a few days' use because they had been mounted with steel spikes. The required heavy duty steel bolts were not available.[49]

The German technical effort to solve the mobility problem in snow centered around developing a wider track for their ACV's. No solutions were forthcoming during the first winter, however, the Germans did start to use wide tracks during the second and subsequent campaigns. The wider tracks adopted solved the problem of snow mobility. Of interest, though beyond the scope of this study, is the fact that ACV's equipped with the wide snow tracks could not be moved on railroad cars or across the standard German military bridges.[50]

Owing to the high ground clearance, powerful engines, and wide tracks, Russian T34 and KV1 tanks moved freely over the terrain even if it was covered with as much as thirty inches of snow. The Russians consistently selected the high ground, woods, and the leeward side of woods and villages for their tank movement.[51] The T34 tank's superb mobility afforded responsive support to the infantry and was the difference between success and failure in many local winter attacks.[52]

The Soviet's experience in winter conditions enabled them to approach the conduct of winter warfare as an exacting science. Special kits were developed to mount on tanks consisting of widened tracks and distinct snow grousers. With those kits, tanks could negotiate snow depths up to four feet.[53] ACV movement was assisted by careful preparation. Roads were maintained in excellent condition. Routes in and out of staging areas, attack positions, etc. were established and maintained to support rapid movement.[54] The Soviets maximized the snow mobility for their ACV's.

The Red Army developed a set of rules or norms for winter operations that covered the main pitfalls of driving over heavy snow. The first rule was considered the most important and was strictly enforced in the Soviet Army. When ACV's were moving in column, it was absolutely necessary for each vehicle to avoid following in the tracks made in the snow by preceding vehicles. Every vehicle had to travel over virgin snow, thereby requiring the whole column to assume an echelon rather than a file formation.[55]

Also important were a thorough reconnaissance of the terrain and great care in choosing the route. The latter consideration was especially important because the snowfall was deeper in ravines, valleys, and all depressions of the terrain than it was on flat or elevated stretches. Depressions and low areas were avoided as much as possible.

According to Red Army experts, the best possible course or route for a tank column was along the elevated portion of the terrain, like hillcrests, plateaus, etc.[56] That guidance was formulated from a mobility standpoint and did not factor in any tactical considerations. Drifts and snow banks were best negotiated at high speed. A narrow ravine filled with snow could sometimes be taken in stride by a fast moving ACV at high speed; the result was the vehicle practically jumping over it. Drifts and high snow banks could sometimes be broken through by backing up a distance, then hurling forward to ram through the snow.[57]

Another rule developed concerned preparation and operation of the ACV. Tracks were not to be stretched too tightly when operating in snow. When track tension was tight, they did not revolve as easily. The result was extra friction and thus wear on suspension components and an additional load on the drive train. To eliminate the danger of stalling in the snow, gear shifting was avoided as much as possible. Unnecessary turns were avoided also. If it was necessary to turn, it had to be done smoothly and in a wide arc movemnt, as a sharp turn increased the likelihood of a track getting thrown (off the road wheels and support rollers).[58]

Before the war experiments were made in the Red Army to pursue snow mobility enhancements. One of these was to reverse the tracks in winter, as many tank officers

maintained that it would improve movement over snow-bound terrain. When tested, the theory proved to be of little practical value. The reversed tracks made deeper furrows, and subsequently, the tanks stalled more frequently. Grousers were found to be a much more efficient means of enhancing mobility. Those used in the Red Army were metal cleats, rounded on the edge, two and one-half inches long. They extended through the whole width of the track block and were attached to the track by means of welding or autogenous soldering. When equipped, each track had five or six grousers evely spaced throughout its length.[59]

The Russian ACV's mobility in snow was so good that when required, tanks were used to tow other vehicles or large gear across country.[60] The Russians were so confident in the T-26 tank's snow mobility they often had the tanks lead the infantry in attack formations.

The Soviets developed an ingenious solution to the problem of snow falling off tree limbs onto the vehicles during movement through wooded areas, thus often obscuring vision and requiring frequent stops. The Red Army experience in the Russo-Finnish War helped to work out the solution, which was validated in the 1941 winter campaign. In such cases as described, the field artillery came to the assistance of the tanks. With several rounds of anti-personnel, shrapnel ammunition, the artillery shelled the areas through which the tanks had to pass. The shelling

knocked the snow off the branches very effectively. It was fortunate for the Red Army that they had retained shrapnel shells, as most armies had eliminated them in favor of the high explosive munitions.[61]

Obstacles required special preparation in order to retain effectiveness. Antitank obstacles such as tetrahedrons or dragons' teeth had to be sited in areas where deep or drifting snow would not accumulate around them, allowing compaction and thus negating their value. Wire obstacles had to be constructed twice their normal height to ensure the ACV's did not just drive over them.[62] These solutions were largely developed by the Germans to counter the excellent Soviet tank mobility. Snow deep enough to negate wire and dragons' teeth obstacles was too deep for German ACV's to negotiate.

The German Winter Warfare handbook prescribed practical, but limited, solutions for reduced effects of field artillery fire in deep snow. The solution to the reduced effect of ricochet and fragmentation was to fire additional rounds in both the adjustment and fire for effect missions using a combination of fuze types. What, in effect, was being provided as a solution was a trial and error system. Heavier caliber guns were prescribed for missions against frozen field fortifications.[63]

Due to constantly changing conditions, the requirement for active reconnaissance was continuous in the

winter. Reconnaissance reports had to be updated as close to the time of unit movements as possible to ensure routes previously reported as passable had not changed. Although not affected as greatly as the Germans in this respect due to far better off-road mobility, the Soviets, nevertheless, established a routine practice of relying extensively on fighting reconnaissance patrols. These patrols were used down to company level. They were sent out to scout the area in the vicinty of the movement not only to determine enemy location and strength, but also to measure snow depth, compaction, and other trafficabilty criteria. The composition of these patrols depended upon their parent unit.[64]

The German solution to changing ACV camouflage requirements was very simple. The ACV's were issued and carried a bucket of lime or chalk so that the crew could apply a new pattern as needed.[65] After snow cover became continuous in early December, this problem was reduced substantially. New patterns were applied when occupying positions with a dark background, such as a forest, or to whiten the previous coat.

Curiously enough, the shortage of mechanized vehicles in the Soviet formations turned out to be an advantage with respect to winter warfare. The retention of the horse cavalry was very fortuitous for the Red Army. When the heavy snows hit in early December, the Soviet horse cavalry

was still mobile. It was able to assume missions, such as guard and reconnaissance, that were previously given to wheeled vehicles. The burden to conduct these necessary operations did not fall upon Soviet ACV's, as they were the only vehicles with in-snow mobility. The Russian horse cavalry maneuvered over deep snow that stalled the German ACV's. The Red Army reportedly used over two hundred thousand horses for cavalry purposes.[66]

That the Soviets were effective in winter operations was evidenced by a contention, after the war, which held that the Red Army was organized into two distinct seasonal armies for summer and winter work respectively. The summer army was equipped like any Western European army. The winter army was a mirror army, clothed in white. Its guns, tanks, and transport were painted white. The tracks on vehicles were wider than normal and ground clearances were increased on these vehicles.[67] There is no evidence to support the thesis and it must be considered false. However, the fact that military minds of the immediate post-war era even considered it is a testimony to the Soviets' ability to effectively prepare for and wage combat operations during a Russian winter.

The Impact of Winter Weather Upon Operations

The Impact Upon German Operations

From the German standpoint, the harsh winter conditions adversely impacted the conduct of both offensive and defensive operations. Given that, it is important to recognize that from early December through to the end of the winter, the campaign consisted of a mosaic of individual battles and engagements. These actions were ceaselessly conducted across the entire front, and, for the most part, were specialized operations of mobile winter warfare.[68] Warfare of this type emphasized tactics at the expense of the operational art. This section will address the tactical, operational, and strategic impacts of the winter of 1941/1942 upon the German forces.

The German forces were not prepared for waging war, especially mobile warfare under the conditions experienced that winter. The campaigns and battles of the summer and early fall had amply demonstrated the German's skillful handling of unit maneuver and supporting indirect and direct fires. The ability to concentrate timely and effective firepower in support of rapid unit movement (maneuver) was the main reason the German advance was so successful during the early months of the war. In maneuver, envelopment was the norm. Rarely did German commanders use frontal attacks, and then only after extensively planned, well executed field artillery fire support was employed. This indirect approach to offensive action avoided enmeshing the German vanguard in battles of attrition. Rather,it defined destruction of the

enemy as death or capture, and permitted spearhead units to continue their rapid advance. Follow-on forces eliminated organized resistance and dealt with the massive numbers of prisoners of war. This allowed lead elements to retain the initiative and sustain momentum.

The Russian winter weather added a new dimension to the battle. The snow and cold robbed the Germans of their great advantages in fire support and maneuver. To the German soldier, it was as if he were fighting a new enemy in addition to the Russians. The Wehrmacht soldiers had to figure out how to defeat, or at least neutralize, this new enemy in order to defeat the other enemy, the Russians. The German organization, equipment, and past training did not provide the soldier the wherewithal to do that. Inexorably, the German offensive drive began to grind to a halt, as the initiative at the squad, section, and platoon levels withered in the face of two enemies. As it turned out, the main objective of winter warfare on the eastern front was coping with the elements and their immpacts in order to retain a pre-winter level of combat power.[69]

It is also important to understand that the change of "tactics" directed by Hitler (from an active to a strongpoint defense) during the campaign generally did not affect how units conducted operations at the tactical level. At company, battalion, and brigade level, the assignment of missions was done without much regard for operational plans.

To a battalion, moving from a given position to come in contact with and destroy Russian forces, was an attack, even though it may have been a counterattack in a higher echelon plan.

The Germans quickly found out that there were two basic prerequisites for winter warfare in Russia. The first was cleared roads; the second was warm quarters. By and large, the tactics of winter warfare centered around contests for the possession of roads and inhabited places.[70]

The ineffectual mobility of the German ACV's in snow placed extreme reliance upon roadways. Cross-country operations were seldom possible by tracked vehicles. As a result of this limitation, more combat power was concentrated on a single axis or route than would normally be the case, a situation which increased vulnerability.[71] German mechanized units were channelized to trafficable roadways both in offensive and defensive operations. The great advantage of maneuver, plied so well by the German Army, was lost due to winter conditions.

A decline in the ability to maneuver presupposes a corresponding increase the volume or lethality of fire support in order to retain a previous level of combat power. This was not the case for the German Army. Across the front, weapons' systems froze due to the intense cold. Positions were lost because ACV's could neither maneuver nor fire their armor defeating weapons.[72] Because of heavy,

continuous snow cover in most sectors of the front, the artillery could not provide effective fire support to the infantry. In order to provide infantry units with increased firepower and mobility, however limited, tank regiments and battalions were attached to infantry divisions, regiments, and battalions. Without these ACV's the infantry was forced to rely upon machineguns and hand grenades to defeat an armored, mobile force.[73]

Villages and towns, rather than enemy force destruction, became key objectives. For soldiers to survive, it was essential that warm billets be secured at night. Tactical objectives were assigned based on villages and towns in the area of operations.[74] This factor tended to limit the depth of movement, offensively and defensively. Commanders were not willing to risk continuing on in the face of uncertainty as to whether they could reach the next town or village by darkness. Additionally, even if they did continue on and made it, other German units may already be occupying the available quarters, thus leaving them without shelter.

The reduction in the depth of operations was also influenced by the increased rate of ACV fuel consumption. The ability of the German logistics units to increase the flow of fuel to forward units was practically nil. Only by reducing deliveries in other sectors could local supplies be increased. Since the frequency of refueling could rarely be

increased, ACV operating ranges were reduced to accomodate this condition.

There were other tactical impacts of the winter conditions which do not fall n atly into broad categories. On the whole, operations were slower. It took longer to prepare and conduct operations in winter. This caused a change in planning procedures for staff elements and in reaction time for units. In winter, simple tasks became more difficult, and more tasks had to be accomplished in order to achieve the same measure of tactical utility as i other seasons of the year.

ACV mobility degradation resulted in a loss of tactical flexibility and a change in mindset on the part of commanders. German defensive tactics called for a strong reserve at the battalion level and above. German doctrine called for the reserve to be positioned nearer the front line in winter than summer, recognizing that everything takes longer.[75] This tended to reduce flexibility somewhat (dependent upon road nets) and marginally increased vulnerability to artillery fire.

By the middle of December, all sectors of the front had completed their changeover to the defensive. In order to ensure an adequate defensive posture, tank units were forced to maintain close contact with the other combat arms. The infantry requested tanks so that they could be located in the most forward positions. The request for and use of

the tanks was often the subject of intense differences of opinion. The positioning of the tanks to the most forward defense line meant a significant reduction in mobility or strong reserve for a counterattack. Additionally, when the tanks were not dug in and expertly camouflaged, they easily disclosed the position to enemy forces. Nevertheless, the infantry commanders often had their way. In many ways this was understandable. The infantry had had to withstand severe hardships to date in that winter campaign and they were very tired. They had come to count on the large cannons and thick armor of the panzers for protection against the attacking Russians.[76]

Fair weather obstacles. such as rivers and lakes, often became trafficable to ACV's in the winter. As such, the number of ACV avenues of approach into a defensive position could increase, requiring an appropriate anti-armor capability for defense on each. Additionally, the relative ineffectiveness of anti-tank mines negated an effective force multipler. Commanders had to evaluate the conditions and their mission to decide what part, if any, of the reseve to commit to the line.

To effectively utilize a strongpoint defense, the Germans had to control and maintain the towns and roads throughout the position.[77] Though much of this task was assigned to rear area logistics units or to forward infantry units, panzer units and other ACV elements were often

required to assist in these operations. This aggravated the fuel problems and increased the hours of operation on already overworked equipment. Much needed combat power was siphoned off for these tasks, thus further depleting the combat forces of available firepower.

A particularly surprising tactic adopted by the Germans was the night attack. The use of this tactic evolved as a matter of necessity. The Germans found that to blunt and clear an area which had been penetrated by a Russian attack, it was necessary to make a local combined arms counterattack. This was difficult and dangerous for the tanks because of their limited mobility. In the deep snow experienced, this normally meant driving down a road with one tank behind the other in column. In daylight, such a counterattack was often held up by a single anti-tank gun. Because of this vulnerability, night attacks became standard procedure.[78]

The German winter night attacks became the model for combined arms cooperation. Together with the infantry, the tanks advanced slowly by bounds. The infantry normally rode on the tanks. Open areas along the route of advance were suppressed by grazing fire from the tank machineguns. These counterattacks were successful in almost every case, with minimal casualties incurred. The greatest caution was necessary when the light of burning houses or similiar objects illuminated the attacking column. At times it was

necessary to halt the attack until the fire(s) abated somewhat. When the snow was very deep, it was necessary to employ "snowshovel commandos" in the attack, in order to dig a passageway through the deep snow, under the protective fire of the tanks.[79]

By and large, the same tactical principles applied to winter warfare as in other seasons. Although the principles were the same, in winter the means to accomplish them were limited considerably by the weather and its effect upon forces and the terrain. Tactically, German units had to modify "how" combat actions were undertaken as opposed to "what" actions were taken.

At corps and division, operational and tactical levels were not clearly separable. As stated previously, for purposes of this study, the operational level will pertain to corps and army levels. This is congruent to the recognizzed definition of the operational level of war, specifically, the theory and application of larger unit operations. It also involves planning and conducting campaigns. Of note is the generally accepted fact that an operation designed to defeat an enemy force in an extended area does so through operational maneuver and a series of tactical actions.[80] The very essence of the operational art of war is the positioning of large forces through maneuver in order to gain a tactical advantage, ergo victory.

The German Army's ability to conduct warfare at the operational level resided exclusively within its mechanized forces. This fact was evidenced throughout the summer campaign in Russia which saw staggering advances and tremendous victories attributable to the speed of the operational maneuver. ACV's were the heart of this capability. Lieutenant General Wilhelm Dietmar stated in a broadcast from Berlin in late April, 1942:

> The early and bitter winter put a halt to the German advances in the east. It diminished the value of our weapons, added cases of frostbite to our casualties, and increased the labours and sufferings of our troops to an unbelievable extent. Our best weapon, speed, was wrung from our hands.[81]

In a very real sense, as the mechanized forces, the ACV's, went, so went the fortunes of the German Army in Russia. The months of October and November slowed the German advance somewhat due to the transitional "muddy" season and early onset of cold temperatures. The latter produced a hesitancy on the part of commanders to continue operations at the previous pace, rather than any significant operational degradation. However, in eary December, the loss of ACV mobility brought about by the heavy snow and brutal cold caused the German offensive on Moscow to stall. That loss of initiative, coupled with the Soviet counteroffensive largely aimed at Army Group Center, dictated that the Germans change their operational plans for the remainder of the winter campaign.

The next operational phase of the campaign was a general withdrawal of forces, largely in the central sector and northern part of the southern sector. The cause of the withdrawal was the strong Soviet counteroffensive launched in early December in the Moscow area. The greatest Soviet success was initially achieved north of Moscow on the Kalinin and Northwest Front. There, for the first time, considerable quantities of German equipment were captured to include vehicles which had become bogged down in the deep snow.[82]

This abandonment of the offensive was not easy for the German High Command to rationalize. It should be remembered that the German Army entered into the conflict with Russia fully confident that its superior mechanized forces would be able to wage a relentless, mobile campaign that would counter Russian desires for positional, largely defensive trench war. However, when the German Army was forced into the defensive, its first aim was to hold positions, especially the positions directly before Moscow. Operationally, additional aims were to shorten their lines by giving up advance wedges and reducing manpower and equipment losses as much as possible. These aims were not achieved.[83]

Instead of German lines being shortened, they were farther extended by Russian wedges. The failure of the Germans to be able to hold defensive lines was due primarily

to their being unable to halt the Russian advance along gaps between divisions and corps, and through lightly defended areas. The German ACV's simply did not possess the over-snow cross country mobility required to adequately defend the wide frontages assigned. Additionally, units were often maneuvered out of position and had to realign forces in order to avert the constant threat of being cut off. Because of the restriction the snow had placed on ACV mobility, it was impossible for the Germans to regroup so that they could react to ever-changing conditions and situations.[84]

In mid-December 1941, Army Group Center was in danger of being penetrated by large Russian forces. In order to prevent that from happening, German force withdrawals were required. In the southern part of Groups Center's sector, Field Marshal Gunther von Kluge, the German Fourth Army commander, was faced with the problem of trying to pull back to more defensible lines while attempting to coordinate the withdrawal of a large tank force, General Guderian's subordinate Second Panzer Group, at the same time. From an operational standpoint, Field Marshal von Kluge did not believe he could pull his own army back safely with out pulling the panzer army on his right flank back at the same time. The weather, however, was preventing the movement of the tanks to the rear. It was reported that hundreds of tanks and other tracked vehicles were abandoned by the

Second Panzer Group in the deep snows, and that tank crews moved westward on foot, fighting as infantry. As a result of this action, many more casualties were suffered than would have occurred if the break in lines had been made. Additionally, the great materiel losses due to abandoning vehicles, whether operational or not, significantly reduced the available German combat power.[85]

Another example further illustrates the operational maneuver problems faced by the Germans. The German withdrawal from Moscow was adversely affected by the cold and snow. After going on the defensive in the suburbs just west of Moscow, the Sixth Panzer Division, commanded bt Generalmajor Erhard Raus, organized a strongpoint defense around the few remaining operational ACV's. When word was received from OKH to begin withdrawing westward to a new winter defensive line, the effective strongpoint defense gave the division time to organize the operation. ACV's that were non-operational, or towed weapon systems without prime movers, were destroyed in place by demolition. Because the snow was so deep, ACV's were roadbound. The ballast of the strongpoint defense, the ACV's, were placed at the rear of march column in order to fend off the Russian advance.[86] The German Army's ability to execute operational maneuver for large force positioning was totally obviated by the winter conditions. Of note also was the fact that the snow in this area was so deep that it prevented the

numerically superior Red Army mechanized forces from enveloping and annihilating the German ACV rearguard.[87]

The winter conditions combined to rob the German Army of its ability to conduct operational maneuver, if not to destroy enemy forces, at least to preserve its own fighting power. It appears the Germans were somewhat slow to realize that they had lost their greatest operational advantage, namely the ability to maneuver and mass combat power, at the decisive point and time, faster than the Soviets. Effective combat maneuver was not possible in the snow depths they experienced. The road net was inadequate to support the movement, let alone maneuver, of large units. Even given certain locales with an adequate infrastructure in terms of a road net, generally each division had only one road available since it was impossible to keep more than one free of snow.[88] In sum, the Germans had lost the operational flexibility and speed of action, so characteristic of their earlier successes, to the Russian winter.

It was not until late December that the OKW realized actions were required to halt what was becoming dangerously close to a rout in the center sector. Field commanders were clamoring for a general withdrawal across the front to a general defense line well to the rear, sited on defensible terrain. The commanders were generally of the opinion that their situation was so precarious with respect to combat power available, particulary ACV's, that it was foolish to

try to accomplish more than a defensive operation for the remainder of the winter. Rather, they reasoned, it would be better to husband resources and rebuild weakened formations while retaining the important ability to meet a pursuing enemy (during winter battles) on favorable terms. The objective of this course of action was to create conditions which would ensure success upon the return of the warmer weather.[89] These were largely strategic considerations purported in an operational context.

The OKW did not acquiesce to the desires of the field commanders. In early January 1942, Hitler directed the OKW to order German units to hold current positions and resist further Soviet advances. According to the OKW directive, German forces in politically and strategically important cities and areas had to permit themselves to be encircled and had to hold out after the front had been rolled back behind them.[90] The concept was to establish concentric defenses in these points and centers, called "hedgehog" or porcupine positions, planned to withstand the most violent attacks. The concentricity enabled the force inside to defend itself by a tremendous concentration of fire.

Though tactically effective, the strongpoint defense was purely passive in both structure and execution. This form of defense was lacking in any form of offensive operational maneuver or counterattack capability.[91] It was ironic that the best use of ACV's in the winter conditions

experienced was a tactical employment in a static defense where no or only limited movement was required. In the winter of 1941/42, this type of defense was successful because the Russians, due to high losses of mechanized equipment, lacked adequate resources for attacking German strongpoints.[92] The use of the strongpoint concept, though loudly decried at the time, was most likely the measure that kept the German withdrawal from turning into a rout. Additionally, it provided for concentration of ACV firepower normally precluded by the winter conditions, i.e., limited mobility prevented or hindered massing of ACV's at a designated point and time.

It is difficult to assess the strategic impact of cold weather induced ACV problems. If one considers the 1941/42 winter campaign a German defeat and ascribes the weather as the primary cause, then indeed the problems experienced by the ACV's played a major role in that defeat. The inability of the ACV's to support attainment of the operational maneuver objectives, the indirect course, forced the Germans to assume a defense posture along with its accompanying change of strategy. Given such a scenario, a second, more subtle strategy emerges which reinforces its own credibility. This was to hold the front as a screen, alternating between strongpoints and conventional linear positions. The forces on this front would be a cover, behind which the combat forces could be reorganized and

necessary resources assembled for a new offensive in the spring and summer. In this scenario, the OKW did not see, nor comprehend the front. To them, the decisive element was not what happened at the front, but what happened behind it.[93]

Red Army comments to the contrary notwithstanding, it is reasonable to conclude that the onset of the Russian winter was a key factor in the failure of the German army to attain the strategic objective of capturing Moscow.[94] For the first time, the German Army had failed to achieve its strategic aims of destroying the Red Army and bringing about the collapse of the Russian state. However, there were many other factors that greatly influenced the German failure to achieve its strategic aims far more than the degraded efficiency of ACV's in the bitter Russian winter conditions. The strength of the Bolshevik system, the toughness of the Soviet soldier, poor German estimates of Russian economic strength, and the deviation from strategic objectives by the OKW were greater contributors to the German failure than the inability of its mechanized forces to operate effectively in the Russian winter.[95] Had no ACV problems been experienced, the result, though less decisive, would have been the same.

The Impact Upon Russian Operations

The impact of the winter elements had much less effect upon Russian operations than on the Germans. As

stated previously, the Soviets were well versed in winter warfare techniques. Although mechanization of the Red Army was only beginning at this time, extensive planning and preparation had been done during the pre-war years for the conduct of mechanized winter warfare. Soviet ACV's were designed for efficient operation in extreme cold and deep snow. In general, soldiers were well acclimated to the brutal extremes of winter weather and by their very nature, stoic in the face of the cruelest climatic hardships and privations.

Though prepared for and cognizant of the winter's influence, the Red Army experienced problems which influenced the conduct of their operations. At the tactical level, both offensive and defensive actions were affected. Rather than leave a procedure subject to improvisation based on the situation, the Soviets desired to eliminate subordinate leader decision points by developing a comprehensive set of tactical norms for all envisioned situations. What follows is a summary of the Soviet tactical norms for offensive and defensive operations developed and used as a result of the winter weather impacts upon the ACV's of the Red Army mechanized forces.

In offensive operations under severe winter conditions, Soviet mechanized force departure areas were positioned closer to the front lines than during other seasons. This permitted Soviet ACV's to retain

approximately the same operating range within enemy territory as in the other seasons, thus off-setting the increase in fuel consumption brought on by the winter. Additionally, due to superb over-snow mobility, Soviet ACV's were used as prime movers for towed equipment and to break trails through deep snow. Neither of these missions had deleterious effects on the Red Army's available combat power as more and more ACV's (particularly the T-34 tank) were being issued to combat units at this time.

Soviet tactical doctrine stressd the use of long winter nights, snowfalls, snow storms, fogs, and intense cold for support of operations.[96] Russian winter attacks always tried to take advantage of the winter weather. Attacks were frequently carried out in the midst of snowstorms or blizzards, particularly when the wind was blowing into the face of the Germans. The defending German ACV's were faced with severely reduced visibility and optical instruments which became snow covered in a very short time. As a result, the Red Army mechanized elements were at the German position, in strength, before the German forces could effectively engage them. This tactic was initially very effective in the center and southern sectors of the front. It is interesting to note that the Germans developed an effective counter-tactic. The Germans would initially emplace their anti-armor weapon systems (ACV and towed) as usual, i.e., on the front line facing the most

likely armor avenue of approach. When security outposts warned of the approaching Soviet force, the ACV's and other anti-armor weapons were pulled off the front line to the flanks. They would let the Russian ACV's go by, then counterattack from the rear of the Russian units, thus making them fight into the wind.[97]

The Red Army found that in deep snow (twenty inches or more) the infantry was unable to match the mobility of the T-34 tank. As a result, they would lag behind the tank advance. Attacks on German positions in villages and towns became piecemeal actions with little support between the infantry and the tanks. Tank vulnerability to German antitank teams increased, as did that to Russian infantryman from bypassed German defenders. The Russians soon modified their tactics by stopping the attacking tanks just short of the German position and neutralizing it by direct fire. Once the accompanying infantry had caught up to the tanks, they would assault together, providing mutual support.[98]

A norm which was developed as a result of the impact of the winter conditions concerned attack routes. In winter, the Red Army usually attacked astride or on roads, or in the paths created by the leading ACV elements. This was done not so much to enhance the mobility of the ACV's as to ensure the supporting arms could maintain the pace of the movement. Additionally, roads within the zone of attack provided the less mobile logistics units a much greater

capability to sustain the combat elements than if they had to operate cross-country.

The deep snow, frigid temperatures, and short days combined to make combat at the tactical level more complicated and its preparation longer. The Red Army found that the slowing of movement caused by the winter conditions was a very important tactical consideration, since a lower tempo of combat resulted in a decline in shock action. To compensate, the Russians changed their tactics by calling for the attacking force to provide continuous, direct and indirect fire onto the target area. This tactic was known as combat by fire.[99] An adverse impact of this tactic was a substantial increase in ammunition consumption. An increase in unit and formation security was required to offset the slowness of deployment in a meeting engagement in heavy snow or other extreme winter condition.[100]

The impact of the winter weather upon Soviet defensive tactics was miminal during this campaign. Except for local occurrences of limited duration, Red Army units were not in a defensive posture. There were very few strong German offensive actions during this winter. The Germans simply did not possess mobility adequate to sustain offensive operations, thereby not challenging Russian defensive tactics. Of some significance was the impact winter had upon the Red Army's selection of defensible terrain. In the winter, Soviet defenses were established

behind natural obstacles. The Soviets soon found out that deep snow alone was a significant natural obstacle to German ACV movement. However, ravines and steep slopes also proved to be excellent natural obstacles. In winter, the emplacement of Soviet defensive positions was guided more by natural obstacles available to impede German mobility than by long range acquisition and fields of fire for the ACV's.[102]

There were occasions, though infrequent, in which the snow had drifted or was so deep that not even Red Army ACV's could negotiate it. When that occurred, the Soviets ACV's became confined to movement on roads.[102] Although the speed of operations increased somewhat, flexibility and vulnerability suffered. Soviet mechanized operations under such conditions were very similar to those of the Germans.

From an operative standpoint, the Red Army rarely exercised the operational level of war during this campaign. During this period, large scale, purely mechanized warfare practically ceased with the retreat of the German Army from Moscow at the beginning of December and did not return in any considerable scale until spring. The Russian tank forces participated on a limited scale in several offensive operations, however, small tank forces supporting infantry offensives was the normal method of employment. Generally speaking, tanks were provided to the infantry to support attacking well-defended villages and strongpoints. Most

operations of that type were local actions and of limited tactical significance.[103] It should be understood that as the Russians saw it, winter combat in times of intense cold required different procedures than would otherwise be customary. It consisted of a constant probing and wearing down of enemy forces through attrition.[104]

That operational warfare was limited to th t great an extent is somewhat surprising considering Russian predictions made before the war. Before the German invasion, Russian mechanized warfare experts considered ACV operation viable for ten months out of the year. The exceptions, or non-trafficable periods, were the three to five week periods at the beginning and end of the winter normally experienced in central and northern Russia.[105]

The limitation to employing mechanized forces at the operational level was more of force structure and maturation that constraints imposed by the weather. The Red Army had suffered staggering losses of men and materiel to the Germans from June to late November. They were just starting to replace those losses with new weapon systems, e.g. the T-34 tank, and were relu nt to commit numerous formations for fear of losing them in a single battle.

As stated previously, there were on occasion actions conducted at the operational level. In early 1942, the Red Army attempted an encirclement of the German Second and Tenth Corps, Northern Army Group. The Northern Army Group

Commander, Field Marshal von Leeb, informed OKH that unless both corps were pulled back, they would be encircled. The matter was taken to Hitler, who refused to allow them to abandon their strongpoints and pull back. As a result, the Demyansk Pocket was created. On 8 February, 1942, elements from several Soviet divisions linked up behind the German Corps after attacking from the north and south. The forces used included infantry ski brigades and tank brigades. In the harsh winter conditions, experiencing temperatures of from minus thirty to minus fifty degrees Fahrenheit, the Soviet forces easily drove through the German units. The Soviet forces were superior not only in numbers but in winter warfare capability, especially the ACV mobility.[106]

In order to determine if there were any strategic impacts caused by adverse cold weather effects upon Soviet ACV's, it is prudent to review just what the Soviet strategy was at that time. Beginning in late December, 1941, there was a complete change in the strategy of both belligerents on the Russian front. The German Army moved from all-out offensive to a passive defense. The Red Army, on the other hand, proceeded from active defense to the offensive with limited aims.[107]

The Soviet strategy of limited aims had a very definite meaning. The Red Army High Command did not envision the winter campaign as the decisive battle - as the German Army had pictured the invasion and then the battle

for Moscow. The Russian counteroffensive was intended to exhaust and wear down the German Army with fewer losses to the Red Army than what t' ey experienced in the defense. The Russians were to wrest the initiative away from the Germans while disrupting and disorganizing German organizations along the front. Just as the Red Army, in the fall of 1941, had prepared for winter warfare, the winter campaign was viewed an an effective way of preparing for the decisive battles of the coming spring and summer. The strategy, simply put, was to place the Red Army in the most favorable, and German Army in the most unfavorable, position by spring.

Another aspect of the Russian strategy of limited aims was to make it possible for them to husband and concentrate their strength for decisive battles to come in the spring. Men and materiel were drawn upon as sparingly as possible during that winter campaign. Objectives were balanced against resources to ensure that losses were justified.108

From a strategic standpoint, there were no Soviet winter weather induced ACV problems which negatively impacted upon Soviet strategic operations. Furthermore,it can be concluded that although the winter weather caused ACV problems for the Soviets, none were experienced of a magnitude or scope which adversely effected the conduct of tactical and operational missions.

ENDNOTES

CHAPTER V: SOLUTIONS TO THE PROBLEMS ENCOUNTERED AND THEIR IMPACT UPON OPERATIONS

1. Corotneff, "Red Army Tanks": 10.

2. Bayerlein, "With the Panzers": 53.

3. King, "POL in the Arctic": 27.

4. German Winter Warfare: 64.

5. Lucas, War on the Eastern Front: 93.

6. Corotneff, "Red Army Tanks": 12.

7. Ibid.

8. Lieutenant General Sir F. Noel Mason-MacFarlane, "Observing the Russians at War," Military Review 2 (1948): 106-107. (Digested from an article in The Journal of the Royal Artillery (Great Britain) October, 1947.)

9. Lucas, War on the Eastern Front: 94.

10. Reudulic, "The Effects of Extreme Cold."

11. Sajer, Forgotten Soldier: 336.

12. Rendulic, "The Effects of Extreme Cold."

13. Munzel, "Tactical and Technical Specialties."

14. T. Varshavski, "Winter Maintenance of Motor Transport," The Cavalry Journal 6 (1942): 47.

15. Chew, Fighting the Russians: 38.

16. German Winter Warfare: 35, 110.

17. Rendulic, "The Effects of Extreme Cold."

18. Chew, Fighting the Russians: 38.

19. U.S. Army, DA PAM 20-201, Military Improvisations During the Russian Campaign (1951): 69.

20. Lucas, War on the Eastern Front: 94.

21. Ibid.

22. German Winter Warfare: 111.

23. Ibid.

24. Ibid.

25. Ibid.: 119.

26. Lucas, War on the Eastern Front: 93.

27. German Winter Warfare: 127.

28. Bayerlein, "With the Panzers": 55-56.

29. German Winter Warfare: 113.

30. Munzel, "Tactical and Technical Specialties."

31. Bayerlein, "With the Panzers": 55.

32. German Winter Warfare: 110-111.

33. McGuire, "Soviet Operations": 29.

34. German Winter Warfare: 130.

35. U.S. Army, DA PAM 20-291: 10.

36. Munzel, "Tactical and Technical Specialties."

37. Bayerlein, "With the Panzers": 55.

38. Munzel, "Tactical and Technical Specialties."

39. Corotneff, "Red Army Tanks": 12.

40. German Winter Warfare: 94, 126.

41. Bayerlein, "With the Panzers": 56.

42. Ibid.

43. Ibid.

44. "Soviet Army Winter Operations," Military Review 6 (1973): 55. (translated and condensed from the original, published in Truppenpraxis (FRG), November 1972).

45. Chew, Fighting the Russians: viii.

46. Munzel, "Tactical and Technical Specialties."

47. Ibid.

48. Ibid.

49. Bayerlein, "With the Panzers": 54.

50. U.S. Army, DA PAM 20-291: 11.

51. Wentzell, "Combat in the East".

52. Manuscript, Generalmajor Hermann B. Mueller-Hillebrand, "Small Unit Tactics: Tactics of Individual Arms (Russian Armored Command); Examples from World War II," 2 January, 1951, Foreign Military Studies # P-060f, H/D, EUCOM.

53. Corotneff, "Red Army Tanks": 10. There are conflicting Soviet claims as to the depth of snow which an unprepared T-34 tank could negotiate. Corotneff, in his article above, reports a capability to negotiate eighteen inches of firm snow. Several other references generally concede that capability to be thirty to thirty-six inches. Every German reference to the cross-country mobility of the T-34 in snow marveled at its capability. The preponderance of evidence supports the claim of being able to negotiate up to thirty-six inches of snow.

54. "Soviet Army Winter Ops": 56.

55. Corotneff, "Red Army Tanks": 10.

56. Ibid.

57. Baxter, "Soviet Norms": 4-5.

58. Corotneff, "Red Army Tanks": 11.

59. Ibid.

60. Wentzell, "Combat in the East."

61. Corotneff, "Red Army Tanks": 11.

62. Wentzell, "Combat in the East."

63. German Winter Warfare: 120.

64. Colonel I. Degtyarev, "Defense in Winter," Military Review 10 (1970): 31. (translated and condensed from an article in VOYENNYY VYESTNIK (USSR), February, 1969).

65. Bayerlein, "With the Panzers": 54.

66. "Cavalry in Russia," The Cavalry Journal 3 (1942): 25. (unsigned article taken from the Army & Navy Journal, May, 1945).

67. Lieutenant Coloned I. G. de Watteville, "Russian Artillery 1941-1945," Military Review 1 (1948): 108. (digested from an article in The Journal of the Royal Artillery (Great Britain), April, 1947).

68. Werner, The Great Offensive: 110.

69. Munzel, "Tactical and Techical Specialities."

70. U.S. Army, DA Pamphlet 20-230, Russian Combat Methods in World War II (1951): 77.

71. Munzel, "Tactical and Technical Specialties."

72. Halder, The Halder Diaries: 1339.

73. Lucas, War on the Eastern Front: 94.

74. Munzel, "Tactical and Technical Specialties."

75. Ibid.

76. Bayerlein, "With the Panzers": 57.

77. Munzel, "Tactical and Technical Specialties."

78. Bayerlein, "With the Panzers": 61.

79. Ibid.

80. U.S. Army, FM 100-5, Operations (1982): 3-2.

81. Allen and Muratoff, Russian Campaigns: 56.

82. Seaton, Russo-German War: 224-225.

83. Werner, Great Offensive: 115.

84. Manuscript, Generaloberst Dr. Lothar Rendulic, "The Influence of Terrain, Seasons, and Weather on Operations in Russia," 20 March, 1947, Foreign Military Studies, MS# D-035, H/D, EUCOM.

85. Clark, Barbarossa: 207.

86. U.S. Army, DA Pam 20-291: 14-15.

87. Ibid.

88. Wentzell, "Combat in the East."

89. Ibid.

90. Ibid.

91. Werner, Great Offensive: 115.

92. Wentzell, "Combat in the East."

93. Werner, Great Offensive: 117.

94. U.S. Army, DA PAM 20-291: 79.

95. USMA, War in Eastern Europe: 60.

96. "Soviet Winter Operations," Infantry 6 (1961): 43 (unsigned article).

97. Mueller-Hillebrand, "Tactics of Arms."

98. Manuscript, General der Infanterie Otto Schellert, "Winter Fighting of the 253d Infantry Division in the Rzhev Area in 1941-42." 9 July 1952, Foreign Military Studies, MS# O-078, H/D, EUCOM.

99. "Soviet Views on Winter Offense," Military Review 1 (1949): 103 (unsigned article).

100. "Soviet Winter Ops": 43.

101. Ibid, : 44.

102. Chew, Fighting the Russians: 33.

103. Corotneff, "Red Army Tanks,": 9.

104. Mueller-Hillebrand, "Tactics of Arms."

105. Corotneff, "Red Army Tanks,": 10.

106. Lieutenant Colonel Joachim Schultz-Naumann, "The Demyansk Pocket, March-April 1942," Military Review 9 (1957): 77. (translated and digested from an article in Allgemeine Schweitzerische Militarzeitschiftr, (Switzerland), November, 1956).

107. Werner, Great Offensive: 113.

108. Ibid,: 113-114.

CHAPTER VI

CONCLUSIONS

> The effect of climate in Russia is to make things impassable in the mud of spring and autumn, unbearable in the heat of summer, and impossible in the depths of winter. Climate in Russia is a series of natural disasters.
>
> General von Greiffenberg
> Chief of Staff,
> 12th German Army

The primary purpose of this chapter is to summarize the findings of the research conducted with respect to the research questions. After addressing the findings, the significance and contribution of this study to the field of military art and science will be examined. Two criteria will be used as a measure of utility. The first is the importance of this study as it relates to the Army's doctrine of war-fighting, the Airland Battle doctrine. The second criterion is the relevance of this study to combat vehicle design and development.

The final area of discussion in this chapter will be the suggestions for future research and study. The suggestions tendered are based largely upon an application focus. The scope of the proposed further research and study centers upon the historical influence of cold weather upon U.S. Army ACV's and projection of those findings toward evolving doctrine.

Study Findings

German ACV's experienced significant adverse effects due to the elements of the Russian winter of 1941/42. That winter was the worst experienced in Russia in over one-hundred years with regard to conditions and duration. The unforseen ferocity of that winter was not the cause of any problems that would not normally have been experienced. It did, however, intensify and prolong the effects of the cold and snow.

The cold weather had the most adverse impact upon mechanized warfare, ACV's, during this campaign. This conclusion is based upon consideration of the ACV from a system perspective. The bitter cold temperatures experienced permeated the entire spectrum of ACV operations. The effect of the cold upon the materiel, the doctrine, and the operators was, at its worst, devastating. It serves little purpose to rank or prioritize the myriad of problems caused by the unrelenting cold. What is important, in this context, is to appreciate the major problems which the cold caused the Germans. It will suffice to be cognizant of other adverse effects which may have caused the same level of privation or mission failure, but on a more localized and somewhat more temporary basis.

The most significant problem caused by the cold temperatures was the freezing of ACV lubricants, fuel, and

antifreeze. Without operable powertrains and armament systems, ACV's ceased to be operationally functional. Combat vehicles that could not move or shoot did not win battles and accomplish assigned missions. Extraordinary measures of expediency and innovation were developed to alleviate the problems. Not all produced the desired results, nor were those which produced the best results successful all the time. However, all corrective action to these problems affected the already over-worked, ill-equipped ACV crews. Frozen lubricants, fuel, and antifreeze in the powertrain and armament subsystems of ACV's burdened the crewmen to a far greater extent than any of the other ACV problems attributable to the cold temperatures.

Another major problem was the direct impact of the cold temperatures upon the ACV crewmen. Continual exposure to the frigid temperatures of that winter sapped ACV crewmen of their strength and spirit. In many cases, the fight against the Russians was secondary to the fight against nature for survival. Incidents of death by freezing was not uncommon to ACV crews. The operational and maintenance burden imposed by ACV's upon their crews far exceeded the burden imposed by other combat weapon systems.

The Germans experienced other problems with their ACV's due to cold weather. Components failed in the bitter cold. Machined metal parts, such as springs and pins,

broke. Optical components frosted externally and internally, the latter requiring disassembly in rear areas to correct. Lead-acid batteries failed, often with cracked cases that could not be repaired. The abnormally high failure rates of such components were exacerbated by the repair part policy dictated by Hitler. The first priority for available parts was in support of monthly production quotas; after meeting production quotas, remaining components could be obligated as spare parts. Needless to say, in a resource-limited, wartime economy, the demands always exceeded the supply available.

The substantial increase in the rate of German ACV fuel consumption was due more to the winter's cold than its snow. For units in the line, the requirement to keep their ACV's ready for action meant considerable, if not often continuous, vehicle idling. This by far exceeded the increased consumption due to snow depths. As German cross-country ACV mobility was practically nil from mid-December throughout the remainder of the winter, ACV movement over snow-cleared or packed roads only slightly increased consumption rates.

The accuracy of large caliber direct and indirect fire weapons were degraded during firing in extremely cold temperatures. This influenced German operations to the extent that fire superiority was often degraded. Additionally, it provided reluctant field commanders with

another reason for not desiring to undertake combat actions under such conditions.

The problems caused by the deep Russian snow were very real also, yet differ somewhat from the cold-induced problems. Very simply stated, the cold effects impacted upon getting the vehicle, or the system, into operation. On the other hand, the snow effect was upon how well the ACV could perform its intended functions after it was operational. With the exception of the mobility aspect, the snow impact was generally limited to a degradation of some portion of the ACV's operational capability; the bitter cold experienced generally resulted in a complete cessation of the capability.

Without question, the greatest effect of the deep and continual snow cover was the adverse impact upon ACV mobility. Due to low ground clearance and relatively high ground pressure (narrow track width), German ACV's did not possess the tractive effort needed to negotiate the depth of snow encountered across the front during this winter. Except for occasional stretches of negotiable, wind-swept high ground (the occupation and use of which increased vulnerability), German tanks and other ACV's were confined to the road networks which had either been cleared or packed down. The restriction of the German Army's primary source of combat power to an inadequate road network severely limited it's flexibility.

Two interesting points arise in relation to the influence of the snow that merit discussion. The first is that, except for localized situations of limited duration, the Russian counteroffensive in early December was the first time the German Army had had to assume either a defensive or a delaying posture on a large scale basis since the beginning of the war with the invasion of Poland in 1939. Concomitantly, because of the snow, the Germans lost their major combat multiplier--the ability to maneuver to position large mechanized forces in order to mass combat po[illegible]t the decisive point.

It has long been recognized that one of the most difficult of all operations to conduct with any measure of success is that of a delay. The German Army Group Center and South conducted such an operation for a two to three week period without the use of maneuver techniques that had largely been responsible for their earlier successes. Though not a failure, the German delay only marginally succeeded in straightening lines and providing mutually supporting, defendable defensive positions. This result was more attributable to the ACV mobility limitations than to the German inexperience in conducting delay operations.

The second point concerns the effect of the lack of ACV off-road mobility upon the type of operation being undertaken. The adverse impacts of the German ACV's road-bound situation were greater in delaying or withdrawal

operations than in offensive operations. In offensive actions, ACV's were limited to single routes of attack on cleared or packed roadways. The resultant column formation, by default, became the attack and assault formation. The columnar attack optimized speed and provided the ultimate in focusing the attack frontage at the expense of being able to mass available fires. The linearity of Soviet defenses permitted both the lead and subsequent vehicles in the column to fire obliquely to the line of march. The ability to fire and suppress the defenders while continuing to press the attack, with reduced vulnerability inherent in the column formation, was often enough to rout the defenders and tip the scales in favor of victory.

On the other hand, a road-bound German delaying force was extremely vulnerable to attrition of its rear elements by the aggressive Russian pursuit. To optimize speed and maintain contact, Russian ACV's would also use the roads. If they could force a positional, one-on-one exchange with rear-element German ACV's, their superior firepower was normally dominant.

There were other effects of snow which degraded the effectiveness of German ACV's. The observation and adjustment of both large caliber direct and indirect fire was more difficult due to the observer's inability to sense the projectile impact. Ballistic terminal effects were substantially degraded due to the deep snow's cushioning

effect. When combined with the effects of the cold, the qualitative edge in firepower enjoyed by the Germans was severly eroded.

The Soviet experience was considerably different from that of the Germans. The difference lies in the impact of the winter's elements (cold and snow) upon the Russion ACV's vice a difference in which element caused the greatest adverse effects. Like the Germans, the extremely cold temperatures had the greatest adverse effect upon the Red Army ACV's. Unlike the Germans, however, the problems did not adversely influence combat operations. This fact was due largely to Soviet planning and preparation for winter warfare in the years before the war, and importantly, although to a lesser extent, to the fact that, by and large, Soviet troops were acclimated to withstand the cruelties of the fierce Russian winters.

The extremely cold temperatures resulted in some of the same difficulties for the Russians as for the Germans. The major Soviet problem was powertrain lubricants freezing in the extreme cold. Soviet technology had not been able to develop powertrain lubricants effective at the lowest temperatures experienced. It is important to understand that temperatures as low as those experienced were not unexpected by the Soviets. That those temperatures lasted as long as they did was unexpected and that was the source of the problems encountered.

Other than the effect of extreme cold upon powertain lubricants, no other significant problems attributable to winter conditions were experienced by the Soviets. Soviet ACV and sub-system design prior to the war had considered and provided for the winter environment. The high ground clearance and wide track of the T-34 tank was the most obvious result of that effort. Where technology was unable to provide a solution, experimentation led to the development of practices and norms which compensated for or neutralized the effect of the weather and permitted continued operation with minimal adverse impact.

The weather-induced ACV problems caused a sigificant impact upon German operations during this winter campaign. The impact was felt across the entire range of the Army's operations, from tactical through operational to the strategic levels. From a tactical perspective, doctrinal procedures for how to fight became irrelevant in the depth of the winter's elements. Offensive and defensive tactics changed because the winter conditions did not support the small unit tactics of the summer and fall campaign. Winter's conditions generally reduced the tactical options available to German commanders. As a result, operations became more predictable and less decisive.

The winter caused a significant shift in tactical objectives. Prior to winter, German tactical objectives had focused on the destruction of enemy forces; territorial

objectives were assigned that goal. Because of the severity of winter's elements, objectives were selected based upon a requirement of shelter for the soldiers participating in the action. Villages and towns took on a new importance because possession often meant survival.

The most significant impact of the cold and snow occurred in the operational arena. For German divisions and corps, the operational level of war involved positioning and timing. German operational plans characteristically employed broad enveloping maneuvers to mass the combat power of the AVC's at locations of Soviet weakness, not strength. The winter conditions effectively combined to preclude the Germans from being able to do that. The snow prevented timely positioning of ACV units due to the dependence upon roads. The cold slowed, and at times stopped, operations, thus making it extremely difficult to mass the required combat power at the needed time.

The Germans found that very little could be done to restore their operational capability during that winter. There were no work-arounds or improvisations available at the operational level. The Russian road and rail infrastructure was inadequate to support rapid administrative movement of mechanized forces to support operational commitment. The decision to go on the defensive was forced upon the Germans by the Red Army counteroffensive; however, the German decision to employ the

strongpoint,or hedgehog, defense essentially prevented a rout and eventual destruction of Army Groups Center and South. The strongpoint defense was almost entirely passive, devoid of any operational level employment considerations. The limited capability remaining to the German ACV's was maximized by the use of that defense.

The German strategy was affected by winter weather-induced ACV problems insofar as the operational capability was severely degraded. The ACV problems were, in and of themselves, not the direct cause of the German failure to achieve its strategic objectives for that winter. However, the inability of the ACV's to support the actions required to ensure success at the operational level led to a change in those operations which resulted in a necessary change of strategy. Therefore, an indirect cause of the failure of the German's original winter strategy was the effect of the cold weather upon ACV's.

It is the author's opinion that the German defeat suffered during this campaign was primarily due to factors other than the impact of the winter weather conditions. The adverse impact of the winter's elements neutralized the German mechanized combat power and forced them to combat the Red Army without their greatest advantage--the ability to maneuver and exercise the operational art of warfare. However, other forces influenced the situation, particularly the strength and resiliency of the Soviet system. The

staggering German equipment losses and high non-battle casualty figures suffered can be ascribed to the winter conditions. Both factors had a long term impact and contributed substantially to the German defeat in the East. The winter was an ally to those who prepared for it; in this case, the Red Army.

For the Soviet's, the effect of the winter weather upon ACV's had only minor adverse impact at the tactical level and no adverse impact at the operational and strategic level. At this stage in the war the Soviets were still relatively inexperienced in mechanized warfare and had not committed their tanks in the large armor formations that would be seen later in the war.

The tactics and operational plans employed after the initiation of their winter campaign were straightforward and simplistic in detail. The ACV winter capability supported the tactics and operational maneuver and vice versa. Soviet practice of the operational level of war during this period closely resembled tactical operations. Plans were simple and objectives not too distant from existing lines. Operations were characterized by the crushing forward momentum of brute force as opposed to the finesse of operational maneuver designed to strike at weak points.

The Soviet strategy was to destroy German forces and regain lost territory, particularly in front on Moscow, so as to provide a buffer to the west of their capital. There

were no adverse impacts caused by winter-related ACV problems upon that strategy. In fact, the superb performance of the Red Army tanks in those adverse conditions was a major reason for the success of that strategy.

Significance and Contribution of the Study

The significance and contribution of this study will be assessed with respect to two major areas. These are doctrinal development and materiel development.

The Airland Battle (ALB) is the current Army war-fighting doctrine. The object of this doctrine is to destroy the opposing force. The foundation of the ALB consists of four basic tenets: initiative, depth, agility, and synchronization. The following paragraphs will briefly address how each of these tenets could be adversely affected by the inability of ACV's to accomplish their mission due to winter weather-induced problems.

Initiative implies an offensive spirit in the conduct of all operations.[1] Its intent is to garner and retain an independence of action. Winter conditions, like that seen in Russia during the winter campaign of 1941/42, will effectively strip a force of its ability to gain and sustain initiative. The weather conditions become a second enemy, though not as directly lethal as the first, but more taxing

due to their everpresent nature. Winter conditions which hinder or prevent mobile formations from operating will significantly reduce the probability of successful actions and practically obviate any subsequent exploitation of the same. Even if the ACV's are adequate to the task of negotiating the winter elements, the impact on personnel who operate and maintain ACV's may be so great as to preclude normal operations and force the acceptance of a loss of initiative.

In the ALB doctrine, depth refers to the use of time, distance, and resources.[2] The time factor is very important. To defeat a numerically superior foe, a coordinated, well-timed effort is required to ensure adequate combat power is available when needed. Commanders and staff planners must be aware of the degradation ACV's will experience when operating under conditions like those prevalent in the winter of 1941/42. The time it will take to accomplish practically all tasks will increase. ACV's, though modern in design, will be hampered by the snow. Like their predecessors, fuel consumption rates will increase and movements will become more shallow in depth. Because of this, planning distances will decrease, adversely affecting both the tactical and operational levels. This lack of depth will adversely impact upon combat support and combat service support systems also. Vulnerability will increase by having to place these elements closer to the combat units

they will support. Additionally, the ability of the existing infrastructure to support both combat and support operations will be severly taxed by the increased densities.

The impact upon modern mechanized forces by winter conditions as experienced on the eastern front in 1941/42 will be difficult to predict with certainty due to the proliferation of many different kinds of ACV's, particularly in light of joint and combined operations. This is where resources must be considered. Snow depths which ACV A negotiates with relative impunity may be an insurmountable obstacle to ACV B. To maximize the resources available, commanders must know the capabilities of each ACV, under given conditions, in order to fully integrate their systems into an executable plan.

Agility is the ability to act faster than the enemy can react. It requires a flexible organization; an organization's flexibility is largely determined by its basic structure, equipment, and systems.[3] This tenant of the ALB doctrine will be greatly affected by the fierce winter conditions like those detailed in this study. Mechanized (and all other) operations will take longer due to the slower pace imposed by the winter elements. This will reduce the decision time available to the commanders. The advantage will acrue to the opposing force commander. Even though he also will be afflicted by the weather conditions, in a reaction mode, he will be operating on

internal lines of communication which will work to his advantage in reducing the time involved. If the enemy force is acclimated to conducting mechanized warfare under harsh winter conditions of extreme cold and deep snow, our ability to sustain a measure of agility will be further exacerbated.

Synchronization is an all-pervading unity of effort throughout the force resulting in coordinated action. Synchronized operations achieve maximum combat power.[4] Commanders will find that winter conditions will jeopardize their ability to synchronize the battle. The main problem will be the ability to unify the effort. As the combat units begin to face the privations and rigors the winter, more and more effort will shift from the combat focus to the requirement to cope with the winter's elements. Winter conditions will become a major obstacle in the ability to synchronize operations and will act to dilute their desired effects. The violent, sustained operations required of mechanized formations to produce decisive results will become more difficult to achieve as the elements take their toll on the ACV's and crewmen.

It would not be prudent to leave the doctrinal arena without briefly addressing the personnel and training issue. The tenants of the ALB doctrine necessarily assume a force comprised of trained, competent soldiers. A generally accepted maxim is that the U.S. Army will fight the same way it trains. If one assumes that to be true, then training in

mechanized winter warfare is required to build the proficiency needed to be combat effective in those conditions. Tank and mechanized units must take advantage of seasonal winter conditions for field training and not confine their efforts to garrison activities. An extensive winter warfare training program will also serve as an excellent vehicle for acclimating personnel to the rigors of winter's elements.

The key to successfully waging the ALB is the operational art. One of the conclusions of this study is that the greatest adverse impact of the cold and snow of the Russian winter was felt at the operational level. All the problems which the German Army experienced during that winter will not be faced by the forces who will fight the ALB - technology has assurred us of that fact. However, some problems may remain relevant. It is hoped this study will stimulate commanders and planners to reflect on what happened during that winter campaign and to address its importance to the conduct of the ALB.

The materiel development aspects are more subtle, yet equally important. Ultimately, the design of an ACV must reflect the capabilities that the user of the system desires of it, otherwise it is of little or no utility. Because of constrained resources, military vehicles, to include ACV's, must operate over a wide range of environmental conditions. Users, generally speaking, desire system operation across

the entire spectrum of environmental (which includes climatic) conditions without any degradation in efficiency. Developers would ideally like to see just the opposite situation, i.e., a narrower range of environmental requirements.

Operational problems arise when ACV's must operate outside the range of environmental conditions for which they were designed. The obvious solution would be not to operate the subject system(s) in that theater. Given the exigencies of national security, such a solution is normally not acceptable. Another obvious solution would be to design ACV's to operate across the entire range of environmental conditions without any degradation in functional performance which would detract from mission accomplishment.

For all practical purposes, it is impossible to design a weapon system as sophisticated as an ACV that will operate in all weather conditions equally well. Even if it could be done, it would be prohibitively expensive. The environmental criteria for ACV's to operate in is generally prescribed by their actual or potential (deployment) theater of operations. The climatic variances of those areas are determined and environmental design criteria are established to coincide or be in close proximity. To be effective, both combat and materiel developers must be knowledgeable of potential operating environments and the impacts upon combat operations if there is an excursion outside predicted

conditions. This study should provide a measure of information, with respect to cold weather impacts, for that task.

Another possible solution to making ACV's fully operational across a wider, if not the total, range of environmental conditions is the use of add-on kits. Basically, this approach would modify the existent design to some undefined extent in order compensate for the effects of a specific climatic factor. Kits are a very attractive option to minimize costs while maintaining force effectiveness. Kit application could be made only to those ACV's operating in the subject theater of operations. Additionally, procurement of kits could be limited to only those ACV's earmarked for that area, thus reducing the total cost exposure.

The kit concept is not without drawbacks, however. The primary concern is that different kinds of kits would not necessarily be developed congruently, or even in a coordinated manner. The danger therein lies in the possibility that a correction for one problem may create an operational problem in some other area. Any shortfalls in the systems approach to design engineering of the kits, or in testing and verification, will increase the potential for this occurrence. Again, it is hoped this study will provide a base of information to assist developers in identifying

problems for which specialized kits may be needed if the requirement should ever arise.

Skepticists might argue that we need not concern ourselves with the problems discussed in this study because there is little likelihood of US forces being deployed to areas which experience winter conditions like those of Russia. With respect to an arctic conflict, the conclusion is often drawn that no one, particularly ground mechanized forces, can operate in those extremes anyway.

Given those arguments, it is logical to assume that no concern need to be given to the conduct of mechanized warfare under extremely harsh winter conditions. However, consider the following figure.

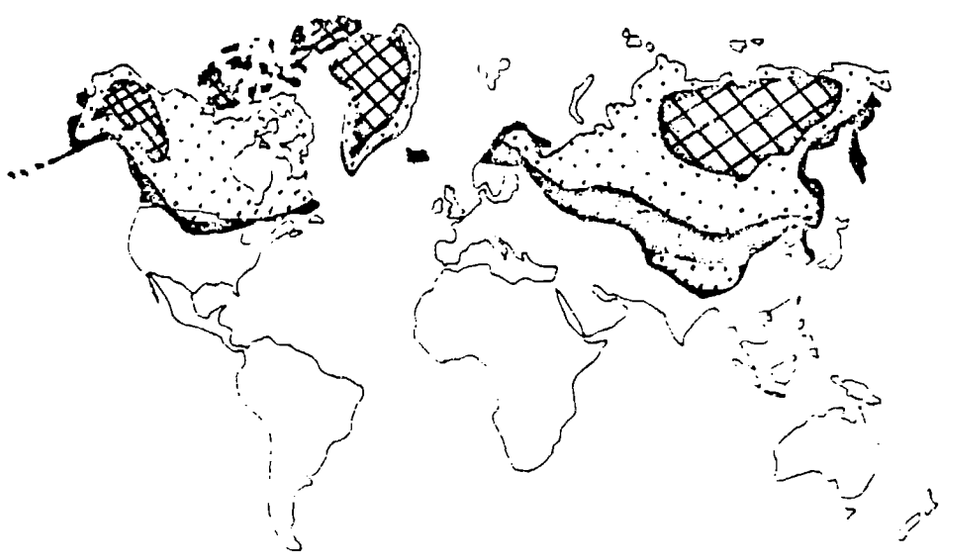

Figure 4. Worldwide Cold Temperature Probabilities

The regions depicted on the map are very interesting. The dark, cross-hatched region has a ninety-nine percent probability that temperatures below minus sixty degrees Fahrenheit will occur in any particular winter. The light, pin-dotted region has a ninety-nine percent probability of a temperature below minus thirty-five degrees Fahrenheit and only a one percent probability of a temperature below minus fifty degrees in a given winter. The solid dark area, generally the most southernly region depicted, is milder but the average annual temperature is below fifty degrees Fahrenheit.[5] The reader is left to draw his own conclusions concerning possible scenarios wherein U.S. forces might be deployed.

Suggestions for Further Research

The following suggestions for further research are submitted regarding the effects of cold weather upon armored combat vehicles.

1. Suggest further study be conducted to assess the impact of degraded mechanized force operations upon the Airland Battle doctrinal tenants. If the tenant(s) of the doctrine are vitiated by the winter environment, the scope and extent of the effect must be analyzed to determine the total impact. Additionally, suggest that the implication for the evolving ARMY 21 doctrine be examined also, insofar as projected technology applications will permit.

2. It is suggested that future studies, as suggested in paragraph one above, include joint and combined force considerations. Cold weather effects will not be selective with respect to services or nationalities. Joint and combined forces are more and more the norm for both conventional and contingency operations. To optimize combat effectiveness, all formations within the force must be capable of integrated and mutually-supporting operations. Knowledge of the possible problems to which ACV's are susceptible in harsh winter environs will help all forces to equip and prepare appropriately.

3. Suggest combat developers review existing ACV requirements' documents to determine if cold weather environmental requirements are adequate given the findings of this study and their potential for occurrence. Subsequently, materiel developers should review ACV development specifications to ensure compatibility with the desired combat capability. Furthermore, consideration should be given to mandatory cold-weather operational testing of all major weapon systems. The latter suggestion is a materiel developer responsibility which should have substantial combat developer interest and support.

4. Recommend further research be conducted to determine the experiences of U.S. Army mechanized forces during winter operations in World War Two on the western front. Although it is recognized that on a general basis

the winter conditions were milder than those experienced on the eastern front, the possibility exists that valid information may be obtained from severe cold and or snow conditions that were experienced on a limited basis.

5. Although not a conflict which can be characterized as mobile in nature, the Korean War is another conflict which may prove beneficial to examine. Suggest the earlier periods of the conflict be researched to determine the impacts of those harsh winter conditions upon ACV's of that era. Particular attention should be given to ACV systems being developed during this period to determine the environmental requirements imposed upon them.

6. It is recommended that further study be conducted concerning the psychological impacts of cold weather upon soldiers. The soldier-machine interface has received considerable attention and emphasis during the current U.S. Army force modernization program. It is vital to understand the impact on those interfaces caused by cold weather psychological factors.

7. It is suggested that further study be conducted to determine the impact of severe winter conditions upon current combat support and combat service support systems. The ALB doctrine mandates integration of all combat and combat service support systems to maximize combat power. Combat service support elements must sustain that level of power. It is esential to determine the effects of winter

conditions upon these supporting systems when considering their importance as elements of combat power.

8. Another area for further study is training in mechanized winter warfare. This campaign aptly pointed out that preparation for winter combat was required for both equipment and personnel. Current winter warfare training programs must be evaluated to ensure that they are adequate. This review must consider the applicability of the training for mechanized operations in the winter elements. It is highly recommended that some portion of the study effort consider the feasibility of establishing a U.S. Army winter warfare training center.

ENDNOTES

CHAPTER VI: CONCLUSIONS

1. U.S. Army, FM 100-5: 2-2.

2. Ibid.

3. Ibid.

4. Ibid. : 2-3.

5. Colonel Francis King, "Cold Weather Warfare: What Would Happen?" Military Review 11 (1977): 88.

APPENDIX 1

APPENDIX 1

GERMAN AND RUSSIAN ACV'S AND CHARACTERISTICS

German ACV's

Panzerkampfwagen IIj (Pzkpfw IIj-tank)
- Weight: 10.5 tons, fully loaded
- Armament: one 20 millimeter gun, one 7.92 millimeter machinegun
  stowed load for main gun: 180 rounds
- Armor: 1.4 inch equivalent frontally
- Ground Pressure: 9.4 pounds per square inch (psi)
- Horsepower/Weight ratio: 12.8/1 ton
- Engine: Mayback HL62 TRM 6 cylinder, gasoline
- Maximum Speed: 25 miles per hour (mph)
- Radius of Action: 125 miles
- Crew: Three
- Number Produced: 1,743

Panzerkampfwagen III h (Pzkpfw IIIh-tank)
- Weight: 23.7 tons, fully loaded
- Armament: one 50 millimeter gun, two 7.92 millimeter machineguns
  stowed load for main gun: 99 rounds
- Armor: 2..2 inch equivalent frontally
- Ground Pressure: 13.6 psi
- Horsepower/Weight ratio: 12.8/1 ton
- Engine: Mayback HL 120 TRM V12, gasoline
- Maximum Speed: 25 mph
- Radius of Action: 110 miles
- Crew: Five
- Number Produced: 2,390

Panzerkampfwagen IVe (Pzkpfw IVe-tank)
- Weight: 23.1 tons, fully loaded
- Armament: one 75 millimeter gun, two 7.92 millimeter machineguns
  stowed load for main gun = 80 rounds
- Armor: 2.3 inch equivalent frontally
- Ground Pressure: 11.4 psi
- Horsepower/Weight ratio: 13.0/1 ton
- Engine: Mayback HL 108 TR V12, gasoline
- Maximum Speed: 27 mph
- Radius of Action: 125 miles
- Crew: Five
- Number Produced: 1,143

Panzerkampfwagen IIIj (Pzkpfw IIIj-tank)
Weight: 24.5 tons, fully loaded
Armament: one 50 millimeter gun, two 7.92 millimeter machineguns
stowed load for main gun: 78 rounds
Armor: 2.0 inch equivalent frontally
Ground Pressure: 13.4 psi
Horsepower/Weight ratio: 12.2/1 ton
Engine: Mayback HL 120 TRM V12, gasoline
Maximum Speed: 25 mph
Radius of Action: 110 miles
Crew: Five
Number Produced: 1,969

Marder IIIm (Pak auf GN-self propelled gun)
Weight: 11.5 tons, fully loaded
Armament: one 75 millimeter gun
stowed load for main gun: 38 rounds
Armor: 1.0 inch equivalent frontally; open at top
Ground Pressure: 8.2 psi
Horsepower/Weight ratio: 10.8/1 ton
Engine: Czech Praga 6 cylinder, gasoline
Crew: Four
Number Produced: 1,558

Sturmgeheschutze III (Stg III-assault gun)
Weight: 24.1 tons, fully loaded
Armament: one 75 millimeter gun, one 7.92 millimeter machinegun
stowed load for main gun: 54 rounds
Armor: 2.1 inch equivalent frontally
Ground Pressure: <13.8 psi
Horsepower/Weight ratio: 12.6/1 ton
Engine: Mayback HL120 TRM V12, gasoline
Maximum Speed: 25 mph
Radius of Action: 100 miles
Crew: Four
Number Produced: 9,003

Schutzenpanzerwagen (SPW-semi tracked armored personnel carrier)
Weight: 9.4 tons, fully loaded
Armament: one 7.92 millimeter machinegun
Armor: .5 inch equivalent frontally
Horsepower/Weight ratio: 13.0/1 ton
Engine: Maybach NL38TR 6 cylinder, gasoline
Maximum Speed: 25 mph
Radius os Action: 95 miles
Crew: Twelve
Number Produced: 34,052

Soviet ACV's

BT-7 Light Tank
Weight: 13.8 tons, fully loaded
Armament: one 45 millimeter gun, two 7.62 millimeter machineguns
stowed load for main gun: 172 rounds
Armor: .8 inch equivalent frontally
Ground Pressure: 10.2 psi
Horsepower/Weight ratio: 32.6/1 ton
Maximum Speed: 32 mph
Cruising Range (road): 260 miles
Crew: Three
Number Produced: 12,000

T-26C Light Tank
Weight: 9.5 tons, fully loaded
Armament: one 45 millimeter gun, two 7.62 millimeter machineguns
stowed load for main gun: 165 rounds
Armor: .8 inch equivalent frontally
Ground Pressure: 12.3 psi
Horsepower/Weight ratio: 9.5/1 ton
Maximum Speed: 19 mph
Radius of Action: 105 miles
Crew: Three
Number Produced: 4,500

T-28C Medium Tank
Weight: 32 tons, fully loaded
Armament: one 76 millimeter gun, three 7.62 millimeter machineguns
stowed load for main gun: 70 rounds
Armor: 2.2 inch equivalent frontally
Ground Pressure: 10.9 psi
Horsepower/Weight ratio: 15.6/1 ton
Crew: six
Number Produced: 4,000

T-34A Medium Tank
Weight: 26.3 tons, fully loaded
Armament: one 76 millimeter gun, two 7.62 millimeter machineguns
stowed load for main gun: 80 rounds
Armor: 2.2 inch equivalent frontally
Ground Pressure: 9.8 psi
Horsepower/Weight ratio: 9.1/1 ton
Engine: water-cooled V-12 diesel
Maximum Speed: 25 mph
Radius of Action: 130 miles
Crew: Four

Number Produced: 10,000

KV-1 Heavy Tank
Weight: 46 tons, fully loaded
Armament: one 76 millimeter gun, three 7.62 millimeter machineguns
stowed load for main gun: 111 rounds
Armor: 4.1 inch equivalent frontally
Ground Pressure: 10.9 psi
Horsepower/Weight ratio: 11.9/1 ton
Engine: 500 horsepower water-cooled V12 diesel
Crew: Five
Number Produced: 2,000

T-60A Light Tank
Weight: 6.4 tons, fully loaded
Armament: one 20 millimeter gun, one 7.62 millimeter machinegun
stowed load: 780 rounds
Armor: 2.1 inch equivalent frontally
Ground Pressure: 7.8 psi
Horsepower/Weight ratio: 13.3/1 ton
Engine: GAZ 202 six cylinder, gasoline
Maximum speed: 27 mph
Radius of Action: 190 miles
Crew: Two
Number Produced: 6,000

NOTE: The ACV's listed in this appendix are those produced and in service during the winter campaign of 1941/42. The reader must keep in mind that as the war progressed, additional ACV's were produced by both combatants.

Sources: Bryan Perrett, The Panzerkampfwagen III (1980).
Walter J. Spielberger & Uwe Feist, Armor on the Eastern Front (1968).
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B.T. White, Tanks and Other Armored Fighting Vehicles 1942-1945 (1975).
Staff of Strategy and Tactics Magazine, War in the East, The Russo-German Conflict, 1941-45 (1977).
U. S. War Department, Technical Manual TM-E 30-451, Handbook on German Military Forces (1945).

APPENDIX 2

APPENDIX 2

ORGANIZATION OF GERMAN AND SOVIET MECHANIZED FORCES

Order of Battle for the First Winter Campaign

The German Army, Initial Order of Battle, 22 June 1941:

ARMY GROUP NORTH: 29 Divisions (20 Infantry, 3 Panzer, 3 Motorized, 3 Security)
ARMY GROUP CENTER: 50 Divisions (31 Infantry, 9 Panzer, 6 Motorized, 3 Security 1 Cavalry)
ARMY GROUP SOUTH: 46 Divisions (29 Infantry, 4 Light Infantry, 1 Mountain, 5 Panzer, 4 Motorized, 3 Security)
OKH RESERVE: 28 Divisions: (24 Infantry, 1 Mountain, 2 Panzer, 1 Motorized)

Changes from 22 June 1941-31 March 1942:

June 1941: add 2 infantry
July 1941: add 23 infantry, 1 mountain, 1 motorized
August 1941: add 11 infantry, 1 light infantry, 1 motorized (light)
September 1941: add 2 infantry
subtract 2 infantry (Slovak)
October 1941: add 3 infantry, 2 panzer
November 1941: add 2 infantry
subtract 5 infantry, 1 light infantry, 1 cavalry
December 1941: add 1 infantry, 1 motorized
subtract 5 infantry (Rumanian)
January 1942: add 6 infantry
subtract 1 infantry
February 1942: add 9 infantry, 2 light infantry
March 1942: add 3 infantry, 1 light infantry 1 panzer

The Russian Army, Initial Order of Battle, 22 June 1941

BALTIC MILITARY DISTRICT: 25 Divisions (19 Infantry 4 Tank, 2 Motorized)
WESTERN MILITARY DISTRICT; 44 Divisions (24 Infantry, 12 Tank, 6 Motorized, 2 Cavalry)
KIEV MILITARY DISTRICT: 58 Divisions (26 Infantry, 6 Mountain, 16 Tank

8 Motorized, 2 Cavalry)

ODDESSA MILITARY DISTRICT: 22 Divisions (13 Infantry, 4 Tank, 2 Motorized, 3 Cavalry)

STRATEGIC RESERVE: 48 Divisions (29 Infantry, 1 Mountain, 11 Tank, 6 Motorized, 1 Cavalry)

Changes from 22 June 1941-31 March 1942:

June 1941: add 2 infantry, 3 cavalry
July 1941: add 80 infantry, 5 mountain, 6 tank, 5 motorized, 6 cavalry
subtract 8 infantry, 2 mountain, 14 tank, 4 motorized, 3 cavalry
August 1941: add 41 infantry, 1 mountain, 2 tank, 1 motorized, 12 cavalry
subtract 13 infantry, 13 tank, 5 motorized, 1 cavalry
September 1941: add 35 infantry, 1 tank, 5 cavalry
subtract 46 infantry, 3 mountain, 17 tank, 3 motorized, 1 cavalry
October 1941: add 32 infantry, 3 mountain, 2 tank, 7 cavalry
subtract 47 infantry, 1 mountain, 10 tank, 1 motorized, 5 cavalry
November 1941: add 26 infantry, 2 tank, 14 cavalry
subtract 6 infantry, 4 tank, 2 motorized 7 cavalry
December 1941: add 39 infantry, 4 cavalry
subtract 1 infantry, 6 cavalry
January 1942: add 45 infantry, 1 mountain, 2 motorized 4 cavalry
subtract 4 infantry, 1 mountain, 1 cavalry
February 1942: add 9 infantry, 1 mountain, 2 motorized, 1 cavalry
subtract 5 infantry, 2 motorized
March 1942: add 22 infantry, 1 mountain, 3 motorized
subtract 8 infantry, 1 motorized, 2 cavalry

German Organizational Structure

German World War II organizational doctrine was based largely upon their World War I experience. The doctrine was developed in response to the key tactical problem of World

War I, namely, how to get infantry forces past heavily defended enemy positions. The German solution was to divide their divisions into two types - trench (or holding) and assault divisions.

Twenty-one years after the close of World War I, the German forces were again practicing operational warfare using this organizational structure. The infantry divisions were the holding forces, while the mechanized, mobile panzer divisions were the assault forces, penetrating the enemy positions and cutting off defending units. This method was the basis of all German operational maneuvers and tactics on the eastern front.

During this campaign the German Army u :d the organizational structure which had served them so well in Poland and France. As the war in the east wore on, the Germans made organizational changes to the structure of their major formations. The purposes of those changes were to enhance fire support procedures, conserve manpower, and improve motorization.

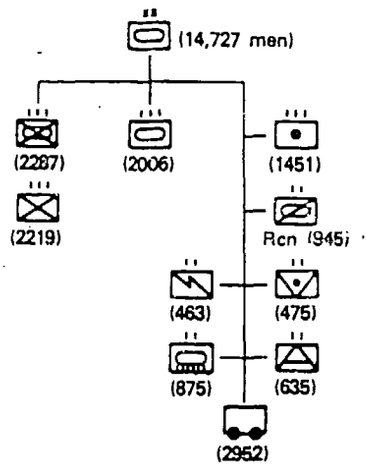
The reader should note that the field army was the main combat component of the German armed forces and the division was the principal combat unit. A major characteristic of the German division was the extreme variation in strength and organization. During this period on the eastern front the variations were actual rather than on paper (by the end of the war, there were more than sixteen different types of

German divisions). Up until 1943, most of the destroyed divisions were immediately rebuilt.

Table 2-1. Evolution of German Panzer Divisions

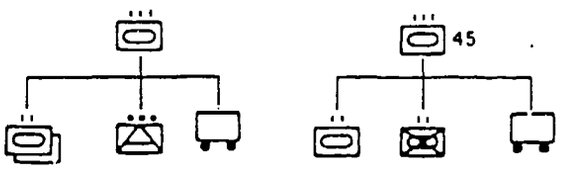
	1941 Panzer Division	1944 Panzer Division
Men	15,600	14,727
Infantry	5,500	5,200
Antitank rocket Launchers	45	-
75 mm antitank gun	75	13
81 mm mortar	30	52
120 mm mortar	-	18
75 mm howitzer	18	-
105 mm howitzer	55	40
Motorized transport	2,900	2,247
Armored combat vehicles	165	503

Figure 2-1. 1944 German Panzer Division



The 1944 panzer division was a simplification and standardization of the 1941 armored division. Shortages of equipment dictated many of the reforms adopted. The earlier divison had no armored infantry battalions in halftracks, as did the latter. The 1944 division also had one battalion of the artillery regiment equipped with self-propelled artillery. The 1941 tank regiment consisted of three battalions; the 1944 regiment of two battalions, although they had more and heavier tanks. See figure 2-4 for symbol legend.

Figure 2-2. Tank Regiment



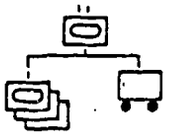
GERMAN TANK REGIMENTS

	1942-43	*1944*	*SS*	*1945*	*Russ*
Men	3000	2006	1771	1361	1306
SMG	182	279	245	377	1260
MG	307	363	296	172	410
20 Gun	12	24	6	33	•
37 Gun	•	8	8	8	•
Pz III	54	•	•	•	•
Pz IV	54	89	64	•	•
Pz V	•	79	62	54	65
AG	31	•	•	•	•
AC	6	•	•	•	•
MT	537	654	313	250	156
AFV	•	12	•	49	•

See figure 2-4 for explanation of abbreviations and symbols.

Figure 2-3. Tank Battalions

GERMAN TANK BATTALIONS



GERMAN TANK BATTALIONS

	1942-43	*1942-43*	*1944*	*1944*	*SS*	*SS*	*AG1*	*AG2*	*TIGER*	*1945*	*Russ*
Men	950	950	752	848	619	716	436	632	649	767	147
SMG	67	67	95	103	103	111	86	209	103	192	30
MG	135	135	112	114	133	135	40	64	108	125	63
20 Gun	•	•	12	12	12	12	•	•	12	21	•
Pz III	70	•	•	•	•	•	•	•	•	•	•
Pz IV	•	70	96	•	96	•	•	•	•	22	•
Pz V	•	•	•	96	•	96	•	•	•	30	21
Pz VI	•	•	•	•	•	•	•	•	45	•	•
AG	•	•	•	•	•	•	31	45	•	•	•
MT	141	141	94	127	94	127	85	103	127	166	16

See figure 2-4 for an explanation of abbreviations and symbols.

Figure 2-4. Abbreviations and Symbols

ABBREVIATIONS:

Men = *total "paper" [full] strength of unit;* Infantry = *all men in infantry, reconnaissance, and engineer battalions;* LW = *Luftwaffe infantry;* VG = *volksgrenadier;* Mtn *mountain infantry;* Lt = *light infantry;* FJ = *fallschirmjager [parachute light infantry];* PG = *panzergrenadier;* Arty = *artillery;* 50 mtr (81, 120) = *50mm [81mm, 120mm] mortar;* 20 gun = *20mm anti-aircraft gun;* 88 gun = *88mm gun;* 75 AT gun = *75mm anti-tank gun;* 75 How (105, 150) = *75mm [105mm, 150mm] howitzer;* FPF = *fire power factor;* % of Div (arty) = *percent of divisional fire power generated by artillery regiment;* MG (LMG, HMG) = *machinegun [light, heavy];* ATL = *anti-tank rocket launchers;* SMG = *submachinegun;* FT = *flame thrower;* AFV = *armored fighting vehicle;* AG = *assault gun;* AC = *armored car;* Pz III (IV, V, VI) = *Panzer III [IV, V, VI] tank;* MT = *motor transport vehicle;* HD = *horse-drawn vehicle*

KEY TO SYMBOLOGY

Infantry

Mechanized Infantry (Panzergrenadier)

Armor or tank (Panzer)


Armored Reconnaissance


Cavalry


Artillery


Self-propelled Artillery


Anti-Tank


Anti-Aircraft (Flak)


Rocket Artillery


Engineer


Signal


Aviation


Transport


Supply

ORGANIZATIONAL SIZE SYMBOLS

•••	Platoon
I	Company or Battery
II	Battalion
III	Regiment
X	Brigade
XX	Division
XXX	Corps
XXXX	Army

Soviet Organizational Structure

The invasion of Russia in June, 1941, brought about considerable change to the Soviet mechanized forces. It was only in early 1941 that the Russians realized what the Germans had known since the mid 1930's. The key to mobile warfare was the combined arms teams of armor, infantry, and artillery.

Most of the large, mobile Soviet mechanized formations were destroyed during the German summer advances. Later, as more armored vehicles came off the Soviet production lines, small armored units were formed which would later (after this campaign) be combined into the Russian equivalent of the German panzer division. Thus, the Soviets formed tank brigades which were the basic tank formation during the first winter campaign. Beginning in 1942, the brigades were formed into tank corps, which for all practical purposes, were tank divisions.

Tank brigades were considered by the Soviets to be a more viable size unit than a division with regard to command and control capability. The disbanded and destroyed tank divisions were used to create the tank brigades as shown in the figure below.

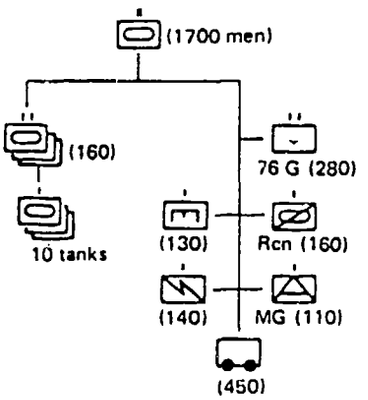
Figure 2-5. Transition to Tank Brigades

		1941						1942				
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
TANK DIVS												
	New	12	34	10	2	4	2	1	0	0	0	0
	Destroyed	3	7	8	11	6	0	0		0	0	0
	Disbanded	0	7	5	6	4	1	2	1	2	0	2
	Total	*9*	*29*	*26*	*11*	*5*	*6*	*5*	*4*	*2*	*2*	*0*
TANK BDES												
	New	0	0	0	10	29	9	6	7	9	6	5
	Destroyed	0	0	0	0	5	1	0	0	1	0	0
	Disbanded	0	0	0	0	0	2	2	4	3	3	0
	Total	*0*	*0*	*0*	*10*	*34*	*40*	*44*	*47*	*52*	*55*	*60*

Thus, the Red Army mechanized forces were in organizational transition during the first winter campaign. The Red Army which was to eventually triumph was not yet in place. The people and equipment were arriving, but the structured changes were not complete.

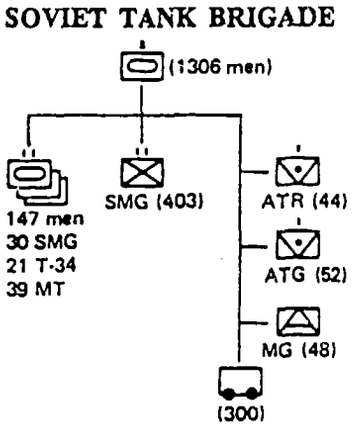
Figure 2-6. 1941 Type Soviet Tank Brigade

1941 SOVIET TANK BRIGADE



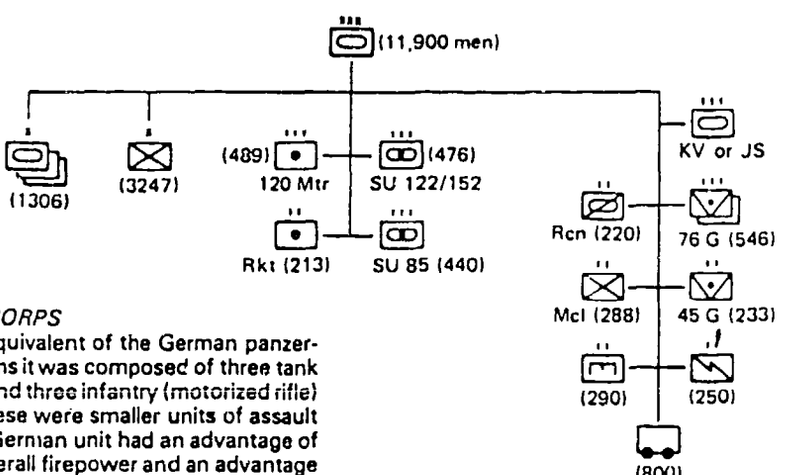
1941 SOVIET TANK BRIGADE
Basically, the problem with this unit was too many tanks and practically no infantry at all. Most units of this type were destroyed during 1941. The "new" 1942 tank brigade replaced it. The main changes were the addition of an infantry element and the elimination of the "fat" support troops. The 76mm gun battalion was also lost.

Figure 2-7. New (1942) Soviet Tank Brigade



1942 SOVIET TANK BRIGADE
Actually, in Western armies this would be considered a tank battalion with two companies of infantry plus small anti-tank and anti-aircraft units attached. This combination of tanks and infantry (all armed with SMG) was ideal, for the infantry's sole duty was to protect the tanks from enemy infantry. The lack of organic infantry in other nation's tank units often caused tanks to be caught without infantry, an event which would often cause more damage to the tanks than to the infantry.

Figure 2-8. Soviet Tank Corps



1942 SOVIET TANK CORPS
This was the Russian equivalent of the German panzer-division. In Western terms it was composed of three tank battalions ("brigade") and three infantry (motorized rifle) battalions. Added to these were smaller units of assault guns and artillery. The German unit had an advantage of 8 percent in terms of overall firepower and an advantage of 40 percent in motor vehicles. But the Soviet unit had 240 AFV to the German's 150 although the Germans also had 20 percent more infantry and 12 percent more men, overall. Like all other Soviet mobile units, this one usually had better men and equipment than non-motorized units. The Guards Tank Corps were particularly well off, as they were equipped with the best and newest armored vehicles. Throughout early 1944 they were about the only units with the T-34/85.

See Figure 2-4 for abbreviations and symbols

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30 August 2001

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DTIC-OCQ, 8725 John J. Kingman Road, Suite 0944,
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